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Portable dual-trace multiplier oscilloscope **PM3265**

Portable dual-trace oscilloscope **PM3265E**

Special model dual-trace oscilloscope with TTL triggering **PM3265E**

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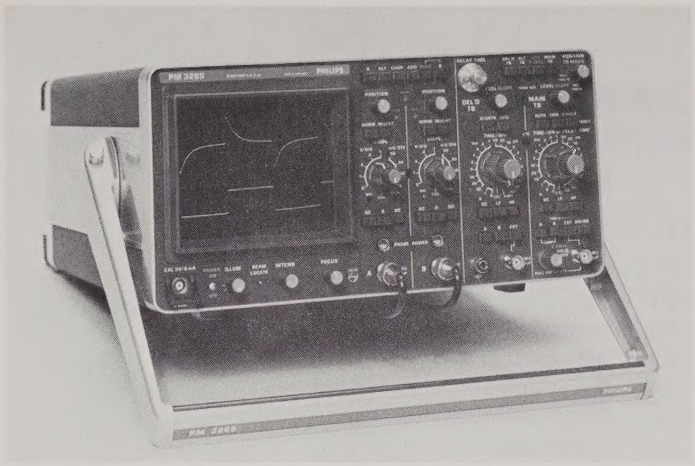

Instruction manual

Portable dual-trace multiplier oscilloscope **PM3265**

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Special model dual-trace oscilloscope with TTL triggering **PM3265E**

THIS SPECIFICATION IS APPROVED
FOR USE IN THE CALIBRATION OF
COMPANY INSTRUMENTS. 5
CALIBRATION DEPARTMENT
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BRITISH AIRCRAFT CORPORATION, STEVENAGE.

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Operating manual

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1. General information

1.1. INTRODUCTION

The PM 3265 Portable multiplier oscilloscope enables the measurement of signals at a high sensitivity (5 mV/DIV) over a large bandwidth (150 MHz). The oscilloscope is provided with many thin-film circuits which guarantee a very stable operation and reduce the number of adjusting points.

There is a wide choice of display possibilities, such as one channel, two channels alternately or chopped, two channels added or multiplied, with normal and inverted positions for both input signals, and a main and delayed time-base, which can be used alternated.

The PM 3265 oscilloscope features a tapless power supply with low dissipation. This power supply works on any a.c. voltage between 90 V and 264 V and d.c. voltages between 125 and 264 V, thus obviating the need of adjusting the instrument to the local mains voltage.

All these features make the oscilloscope suitable for a wide variety of applications.

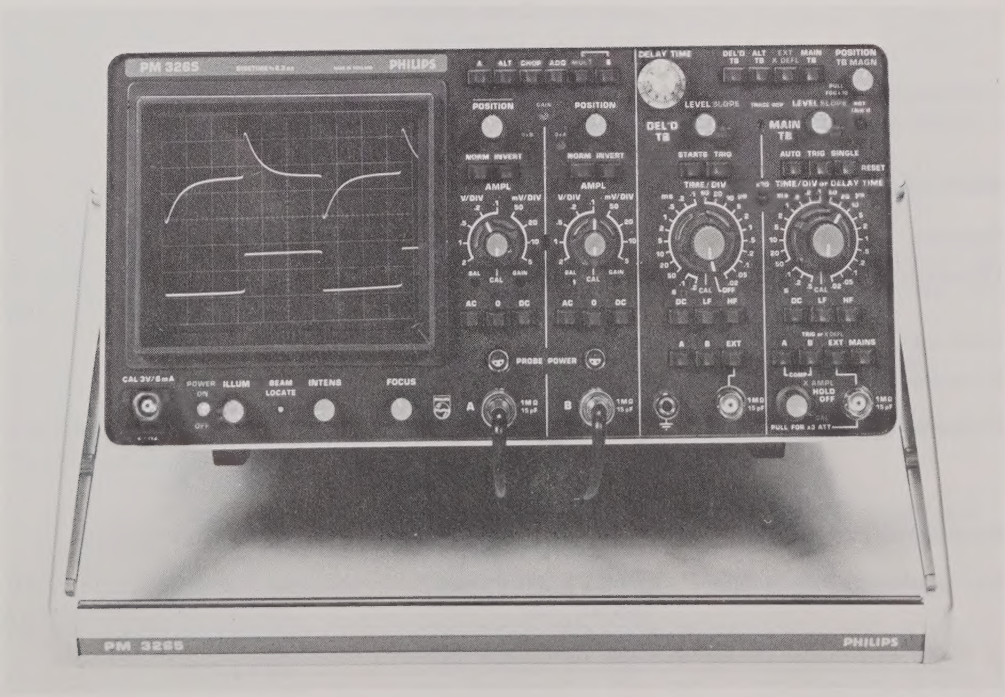


Fig. 1.1. Portable multiplier oscilloscope PM 3265

1.2. CHARACTERISTICS

This instrument has been designed and tested according to IEC Publication 348 for Class I instruments and has been supplied in a safe condition. The present Instruction Manual contains information and warnings which shall be followed by the purchaser to ensure safe operation and to retain the instrument in a safe condition.

This specification is valid after the instrument has warmed up for 30 minutes. Properties expressed in numerical values with tolerances stated, are guaranteed by the manufacturer. Numerical values without tolerances are typical and represent the characteristics of an average instrument.

Designation		Specification	Additional information
1.2.1.	C.R.T.		
	Type	PHILIPS D14-240	Rectangular tube face, domed mesh type, post-accelerator, metal-backed phosphor
	Measuring area	80 mm x 100 mm	
	Screen type	P31 (GH) phosphor	P7 (GM) phosphor optional
	Photographic writing speed	$>$ 1500 cm/μs	Measured with Steinheil Oscillophot M5 camera. Aperture: 1:1,2 Object to image ratio: 1:0,5 Film: Polaroid 410 (10000 ASA) No pre-fogging Phosphor type P31 (GH)
	Total acceleration voltage	19 kV	
	Graticule	Internal	Continuously variable illumination
	Engravings	Centimetre divisions with sub-divisions of 2 mm along the central axis. Dotted lines indicate 10 % and 90 % of measuring lattice for measurement of rise time	
1.2.2.	VERTICAL OR Y AXIS		
1.2.2.1.	*Response*		
	Frequency range	d.c. ... 150 MHz 10 Hz ... 150 MHz	−3 dB bandwidth d.c. coupled −3 dB bandwidth a.c. coupled
	Rise time	$\approx$ 2,3 ns	
	Pulse aberrations	±3 %	4% peak to peak
1.2.2.2.	*Deflection coefficients*	5 mV/DIV ... 2 V/DIV	Nine calibrated positions in 1-2-5 sequence. Uncalibrated continuous control 1 : $\geqslant$ 2,5
1.2.2.3.	*Error limit*	±3 %	
1.2.2.4.	*Max. permissible input voltage*	±400 V 800 $V_{p\text{-}p}$ a.c.	d.c. + a.c. peak. Up to 20 mV position of input attenuator derating at frequencies over 500 kHz. See Fig. 1.2

Designation	Specification	Additional information
1.2.2.5. Instability of the spot position		
Trace jump	< 0,3 Div	When switching between any of the attenuator positions.
Trace jump	< 1 Div	When switching the NORM/INVERT switch
Trace shift	< 0,3 Div	When rotating the continuous attenuator
Trace shift	< 1 Div	When switching to the ADDED position
Temperature drift	< 20 μV/°C	Typical value
1.2.2.6. Maximum deflection	24 divisions	Undistorted
Shift range	16 divisions	8 divisions each in topward and downward direction reckoned from the central horizontal graticule line
1.2.2.7. Input impedance	1 MOhm//15 pF	
1.2.2.8. Input RC time	⩾ 17 ms	Coupling switch to AC
1.2.2.9. Visible signal delay	Approximately 30 ns	
1.2.2.10. Display modes	Channel ± A only Channel ± B only Channels ±A and ±B chopped Channels ±A and ±B alternate Channels ±A and ±B added Channels ±A and ±B multiplied Channels ±A and ±B multiplied with channel B chopped or alternate	
1.2.2.11. Chopper frequency	≈ 1 MHz	
1.2.2.12. Cross-talk between channels	1 : 500	2 divisions of signal amplitude at 50 MHz on one channel set to 2 V/ DIV. Cross-talk is measured on other channel set to 20 mV/DIV
1.2.2.13. Common-mode rejection factor	100 at 100 kHz 100 at 2 MHz 20 at 50 MHz	Measured with +A and −B added; max. common mode signal 8 divisions
1.2.2.14. Y out	100 mV/Div into ⩾ 10 kΩ ±2% 50 mV/Div into 50 Ω ±5%	BNC at rear panel
Frequency range	DC ... 150 MHz	Dynamic range 8 Div
Pulse aberrations	5 %	
Output level	zero	Adjustable at rear panel
Output drift	⩽ 1,5 mV/°C into 50 Ω ⩽ 3 mV/°C into ⩾ 10 kΩ	
1.2.2.15. Multiplier display modes	Product (signal ±A x Signal ±B) only Product (signal ±A x signal ±B) and signal ±B chopped or alternate	Chopped ⩽ 5 mS MTB setting Alternate > 5 mS MTB setting
	For XY modes; refer to chapter 1.2.6.	
1.2.2.16. Multiplier bandwidth	100 MHz (−3 dB)	Measured with a sine wave to one channel and a DC signal to the other

Designation	Specification	Additional information
1.2.2.17. Multiplier rise time	≈ 3,5 ns	
1.2.2.18. Scale factor	1 ±2 %	The product of a signal giving A div. display via input Ya and a signal giving B div. display via input Yb, will produce A x B div.display within 2 %. (Adjustable at front panel) Temperature coefficient 0,1 %/°C
1.2.2.19. Non-linearity	Max. 4 % of full screen deflection (±0,16 Div)	Non-linearity is the peak deviation of (A x B) = f(B) from an ideal straight line measured at 1000 Hz.
1.2.2.20. Multiplier dynamic range	Signal A max. 8 Div p-p (±4 Div from screen centre) Signal B max. 8 Div p-p (±4 Div from screen centre) Product A x B max. 8 Div p-p (±4 Div from screen centre)	
1.2.2.21. Feed through	⩽0,3 div. up to 25 MHz 0 x A ⩽ 0,5 div. up to 100 MHz 0 x B ⩽ 1 div. up to 100 MHz	Spurious product of one signal zero, other signal a sine wave of 8 div./signal referenced to the 50 kHz voltage of a constant voltage generator.
1.2.2.22. Product offset	⩽ 0,3 Div.	Shift of the base line when switching from the Alt or Chop mode to the mult mode or mult and Channel B mode.
1.2.2.23. Product offset drift	⩽ 0,03 Div/°C	
1.2.2.24. Propagation delay	≈ 6 ns	Delay between the product and one of its factors.
1.2.2.25. Noise at full bandwidth	⩽ 0,3 Div.	Measured tangentially Reduced noise at limited bandwidth (internal setting)
1.2.2.26. Y Out in Multiplier AxB mode		
Bandwidth	0-100 MHz	(−3 dB)
Scale factor	100 mV ±2 % into ⩾10 kΩ for each div. of the displayed product 50 mV ± 5 % into 50 Ω for each div. of the displayed product	
Output level	zero	Adjustable at rear panel
Output drift	⩽ 1,5 mV/°C into 50 Ω ⩽ 3 mV/°C into ⩽ 10 kΩ	
1.2.3. HORIZONTAL OR X AXIS		
1.2.3.1. Display modes	− Main time base − Main time base intensified by delayed time base − Delayed time base − Main time base and Delayed time base alternated − XY Operation	X deflection by: − Channel A signal − Channel B signal − Composite A and B signal − Signal applied to EXT connector of main time base − Mains frequency

Designation	Specification	Additional information
1.2.4. MAIN TIME BASE		
1.2.4.1. Operation	Triggered Automatic Single shot	Possibility of automatic free-running in the absence of triggering signals
1.2.4.2. Time coefficients	0,5 s/Div ... 20 ns/Div	Twenty-three calibrated positions in 1-2-5 sequence. Uncalibrated continuous control 1 : ⩾ 2.5 between the steps
1.2.4.3. Coefficient error	±2 % ±3 %	+20 °C ... +30 °C +5 °C ... +40 °C Sweep accuracy over any two divisions of 10 div sweep is ±5 %. Exclude the first and last div at the 2 ns, 5 ns and 10 ns magnified sweep rates.
1.2.4.4. Expansion		
Magnification	10x	Switched, calibrated
Additional error	±1 %	First and last 50 ns of 2 ns, 5 ns, 10 ns and 20 ns magnified sweep rates excluded.
Fastest sweep rate	2 ns/Div	
1.2.4.5. Variable hold-off time	The sweep hold-off time can be increased by approximately a factor of 10	Not operable at .02, .05, .1 and . 2 µs/Div.
1.2.5. DELAYED TIME BASE		
1.2.5.1. Operation	Delayed time base starts either immediately after the delay time, or upon arrival of the first trigger pulse after the delay time	
1.2.5.2. Time coefficient	0,2 s/div ... 20 ns/div	Twenty-two calibrated positions in 1-2-5 sequence. Uncalibrated continuous control 1 : ⩾ 2,5 between the steps.
1.2.5.3. Coefficient error	±2 % ±3 %	+20 °C ... +30 °C +5 °C ... +40 °C Sweep accuracy over any two divisions of 10 div sweep is ±5 %. Exclude the first and last div at the 2 ns, 5 ns and 10 ns magnified sweep rates.
1.2.5.4. Delay time	Continuously variable between 0x and 10x the time coefficient of the main time base	Calibrated. Range delay-time multiplier 0,00 - 9,99. Incremental accuracy 0,5 %; typical 0,2 %.
1.2.5.5. Delay-time jitter	⩽ 1 : 20 000	
1.2.5.6. Alternate Time Base	Main time base and Delayed time base alternated. Max. vertical separation ⩾ 4 div.	Continuously adjustable on front panel
1.2.6. X DEFLECTION		
X Deflection via channel Y_A		
1.2.6.1. Deflection coefficient	5 mV/div. ... 2 V/div	Uncalibrated continuous control 3:1 via X AMPL potentiometer

Designation	Specification	Additional information
1.2.6.2. Coefficient error	±5 %	
1.2.6.3. Bandwidth	DC ... 3 MHz	–3 dB bandwidth over 8 div.
1.2.6.4. Input impedance	1 MOhm//15 pF	
1.2.6.5. Phase difference	$\leqslant 3^{o}$ at 2 MHz	

X Deflection coefficient via channel Y_B or composite

Same as for X deflection via Y_A channel, but with a possible coefficient error of ±20 %.

External X deflection via EXT input

1.2.6.6. Deflection coefficient	350 mV/DIV approx. 1 V/DIV approx. at 3x Attenuated	In calibrated position In calibrated position	(uncalibrated continuous control $\geqslant 3:1$)
1.2.6.7. Bandwidth	DC ... 3 MHz	–3 dB bandwidth over 8 div continuous	
1.2.6.8. Input characteristics	Identical to Y channels		
1.2.6.9. Maximum permitted input voltage	± 400 V	d.c. + a.c. peak derating at high frequencies (See Fig. 1, 2)	
1.2.6.10.Phase difference	$\leqslant 3^{o}$ at 100 kHz		

X Deflection with internal voltage at mains frequency

The deflection depends on the mains voltage and has been factory-adjusted to 8 div at a mains voltage of 220 V.

1.2.7. TRIGGERING OF THE MAIN TIME BASE

1.2.7.1. Source	Internal from channel A Internal from channel B Internal composite signal from both channel A and channel B Internal from mains External source	
1.2.7.2. Mode	Automatic	Automatic free-run of the time-base generator approx. 100 ms after disappearance of the trigger signal.
	Manual level Single sweep	
1,2,7,3, Slope	+ or –	
1.2.7.4. Sensitivity	Internal 0,5 DIV up to 100 MHz 1 DIV up to 150 MHz External 150 mV	
1.2.7.5. Filter bandwidth	DC: 0 - 150 MHz LF internal: 0 - 20 kHz approx. –3 dB LF external: 10 Hz - 20 kHz approx. –3 dB HF: 20 kHz - 150 MHz approx.	Both internal and external –3 dB, both internal and external
1.2.7.6. Level range	24 DIV –3,6 V to +3,6 V –11 V to +11 V	at internal trigg. at external trigg. at external trigg., 3xAttenuated
1.2.7.7. Input characteristics	Identical to Y channels	

Designation	Specification	Additional information
1.2.8. TRIGGERING OF THE DELAYED TIME BASE		
1.2.8.1. Source	Internal from channel A Internal from channel B External	
Other characteristics are identical to TRIGGERING OF THE MAIN TIME BASE.		
1.2.8.2. Mode	Starts	Triggered by main sweep immediately after delay
	Trig	Triggerable after Delay Interval
1.2.9. CALIBRATION UNIT		
1.2.9.1. Output voltage	3 V_{p-p}	
1.2.9.2. Output current	6 mA	
1.2.9.3. Error limit	±1 %	Both voltage and current
1.2.9.4. Frequency	2 kHz < 2 %	
1.2.9.5. Protection	The output is protected against continuous short-circuits	
1.2.10. ADDITIONAL INPUT AND OUTPUTS		
1.2.10.1. Z Input		
Connector	BNC	At rear panel
Input impedance	1 MΩ/15 p	
Max. permissible input voltage	as Y inputs	
Freq. range	DC ... 10 MHz	
Input voltages	0 V total unblanked −10 V total blanked	For PM 3265 S/N D01 601-D01 800
	+5 V total unblanked 0 V partly blanked −5 V total blanked	For PM 3265 from S/N D02-801 onwards
1.2.10.2. Main Time Base		
Connector	BNC	At rear panel
Output voltage	0 ... +5 V_{p-p}	
Output impedance	5 kΩ	
Protection	The output is protected against continuous short-circuits	
1.2.10.3. Delayed Gate		
Connector	BNC	At rear panel
Output voltage	0 ... +5 V_{p-p}	+5 V during delayed sweep
Output impedance	3 kΩ	
Protection	The output is protected against continuous short-circuits	

Designation	Specification	Additional information
1.2.11. POWER SUPPLY		
1.2.11.1 Mains voltages	AC: between 100 and 240V, ±10 % DC: between 130 and 350V, ±10 %	Between +5 and 40 °C. 90 VAC at limited mains voltage distortion; peak value/r.m.s. value = $\sqrt{2} \pm 2$ %, B ⩽ 0,05 (IEC 359).
1.2.11.2 Mains frequency	46 to 440 Hz or DC	
1.2.11.3 Probe power	+ and −24 V	Max. 100 mA between +5 and +40 °C
1.2.11.4 Power consumption	50 W	Probe power excluded.

1.2.12. ENVIRONMENTAL CHARACTERISTICS

The environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS Organisation in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN
Test and Measuring Instruments Dept.
EINDHOVEN - HOLLAND

1.2.12.1. Ambient temperature	+5 °C ... +40 °C	Rated range of use	according to IEC68 Ab and Bb
	−10 °C ... +55 °C	Limit range of operation	
	−40 °C ... +70 °C	Storage and transport conditions	
1.2.12.2. Altitude	5 000 m	Operating	
	15 000 m	Not operating	
1.2.12.3. Humidity	damp heat cyclic 25° - 40° C RH 95 %		
1.2.12.4. Bump	1000 Bumps of 10g, ½ sine, 6 ms duration, in each of 3 directions		
1.2.12.5. Vibration	30 minutes in each of three directions, 10 - 150 Hz; 0,7 mm p-p and 5 g max. acceleration.		
1.2.12.6. Recovery time	15 minutes for normal operation	Coming from −10 °C and going to +20 °C at 60 % relative humidity **Warning:** When an instrument is brought from the cold into a warm environment, condensation may cause a hazardous condition. Therefore, make sure that the earthing requirements are strictly adhered to.	
1.2.12.7. Electromagnetic interference	The instrument meets the VDE, Störgrad K, requirements		

1.2.13. MECHANICAL DATA

1.2.13.1. Dimensions	Length 410 mm (16 1/4") Width 316 mm (12 1/4") Height 154 mm (6 1/8")	Excl. controls, cover and feet
1.2.13.2. Weight	approx. 10 kg (22 lbs)	

*For IEC references see also Philips Data Sheet:
Quality Assurance Program Oscilloscopes No. 17.7200.32.0556.11.

1.2.14. ACCESSORIES

1.2.14.1. Accessories delivered with the instrument

Two contrast filters (one installed)
Front cover with storage space for probes
Collapsible viewing hood PM 9366
Banana - BNC adapter PM 9051
CAL terminal - BNC adapter
Manual

1.2.14.2. Optional accessories

PM 9335 (L)	Passive 1:1 probe
PM 9351 (L)	Passive 10:1 probe
PM 9358	Passive 100:1 high-voltage probe
PM 9347	Active t.v. probe
PM 9352	Active microminiature probe
PM 9353	Active F.E.T. probe
PM 9355	Current probe with amplifier
PM 8960	Rack-mounting adapter
PM 8971	Camera flange
PM 9380	Oscilloscope camera
M3, M4, M5	Oscilloscope camera range Steinheil Oscillosphot
PM 8991	Oscilloscope trolley
PM 8980	Long viewing hood

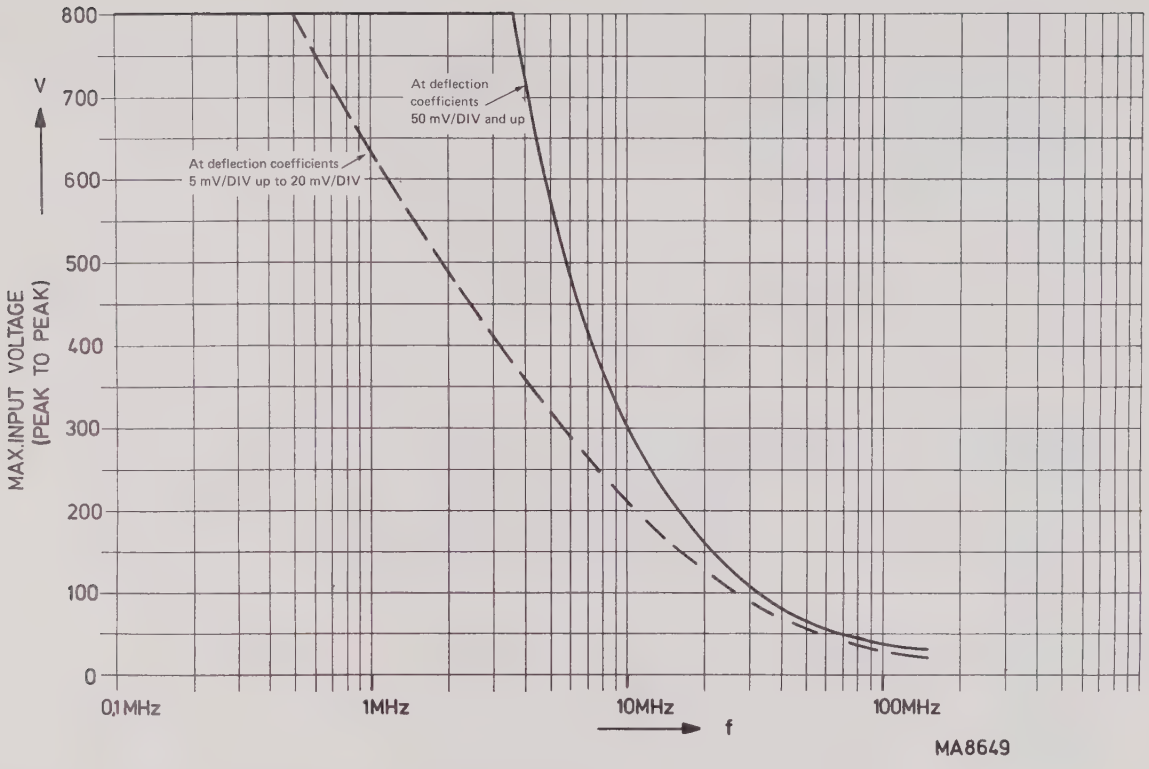


Fig. 1.2. Derating of the maximum permissible input voltage as a function of frequency

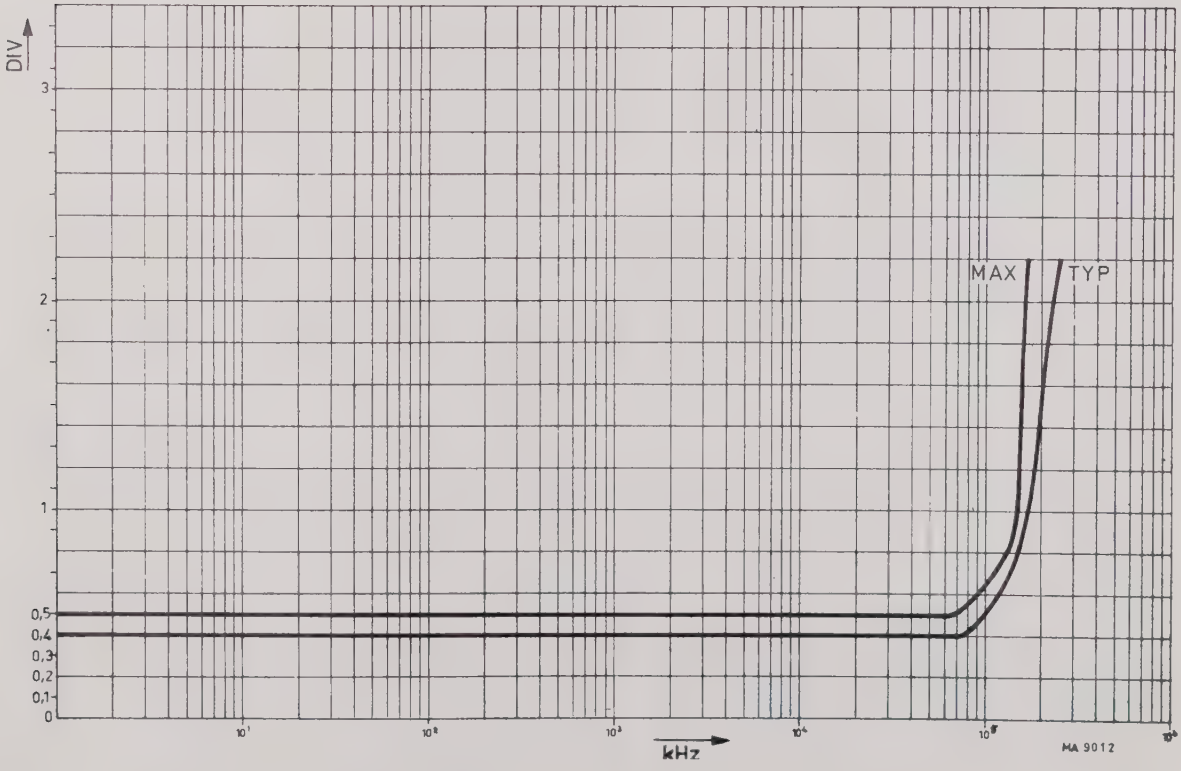


Fig. 1.3. Trigger sensivity as a function of frequency

1.3. GLOSSARY OF MULTIPLIER TERMS

1.3.1. Analogue multiplier

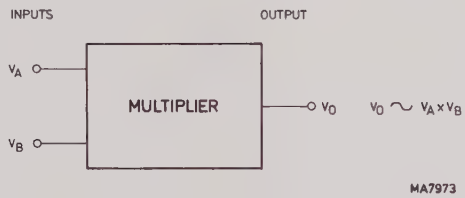


Fig. 1.4. Analogue multiplier

An analogue multiplier is a non-linear device which produces an output voltage that is proportional to the algebraic product of two input voltages

1.3.2. Multiplier bandwidth

The multiplier bandwidth is the frequency range between DC and the frequency at which the multiplier output is 3 dB down with respect to the output at a given low frequency.
This bandwidth is specified by a constant amplitude sine-wave with variable frequency applied to one input and a DC voltage to the other.

1.3.3. Multiplier rise-time

The multiplier rise-time is the response time of the output swing when a step voltage is applied to one input and a DC voltage to the other.
This time is measured between the 10 % and 90 % points of the step response.

1.3.4. Four quadrant operation

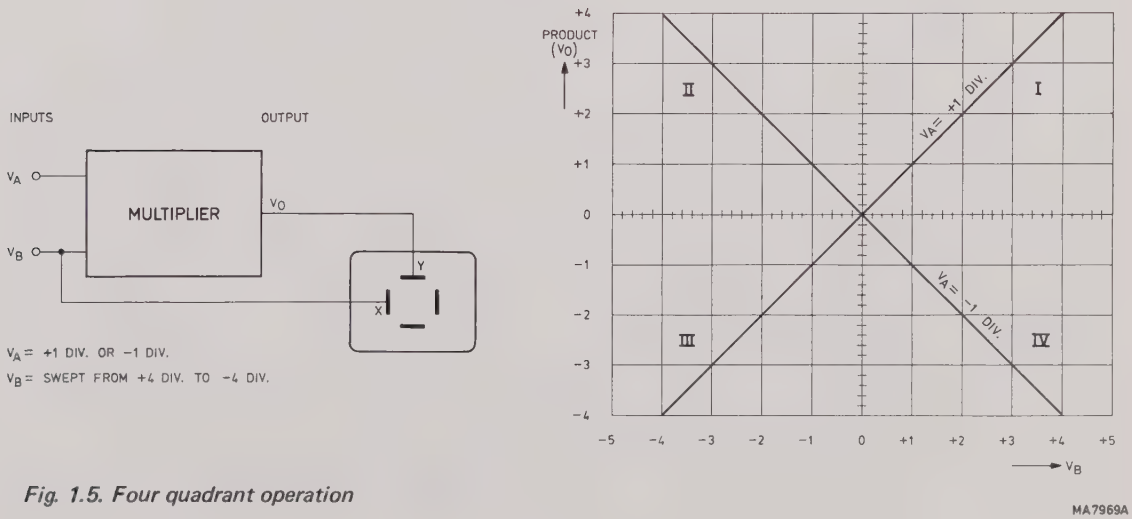
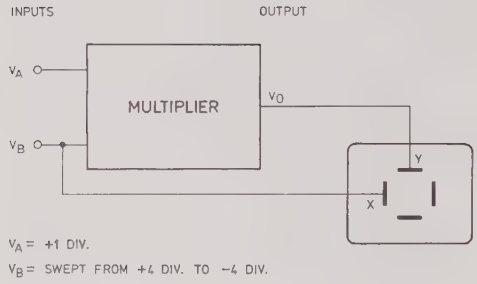


Fig. 1.5. Four quadrant operation

A four-quadrant multiplier can produce an output signal in any of the four quadrants (marked I to IV) of the Cartesian co-ordinate system.

1.3.5. Input off-set



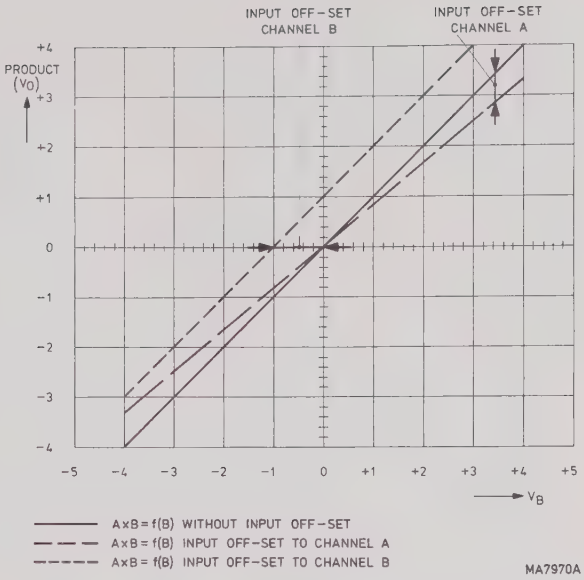
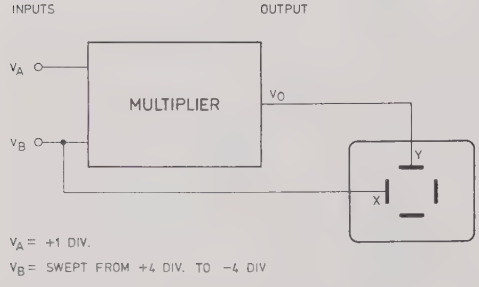


Fig. 1.6. Input off-set

The input off-set is the virtual voltage at the multiplier input when no input signal is applied. This off-set can be minimized by applying a DC balance voltage.

1.3.6. Output off-set



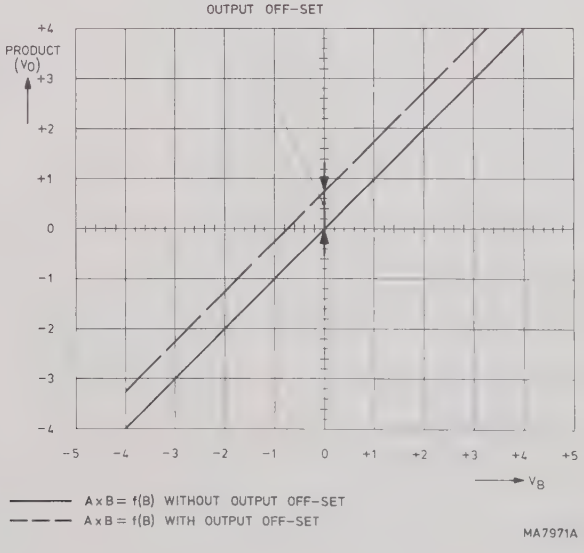


Fig. 1.7. Output off-set

Output off-set is the unwanted voltage at the multiplier output when both input signals are zero. This output off-set is visible as a vertical shift of the displayed product.

1.3.7. Scale factor

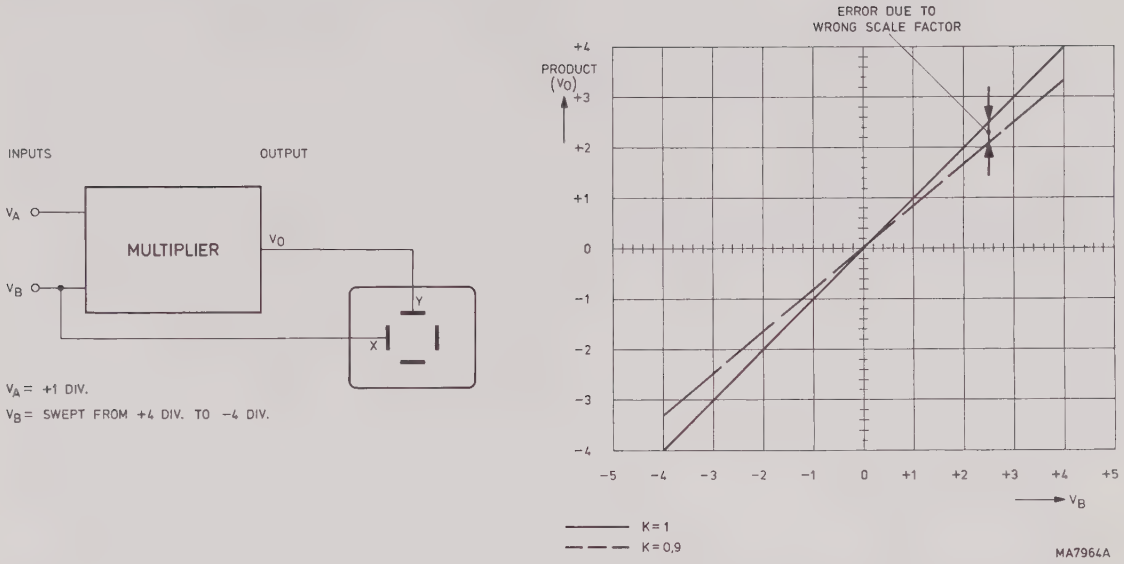


Fig. 1.8. Scale factor

The scale factor K is the constant of proportionality that relates the C.R.T. deflection to the inputs A and B in the MULT. mode.

1.3.8. Non-linearity

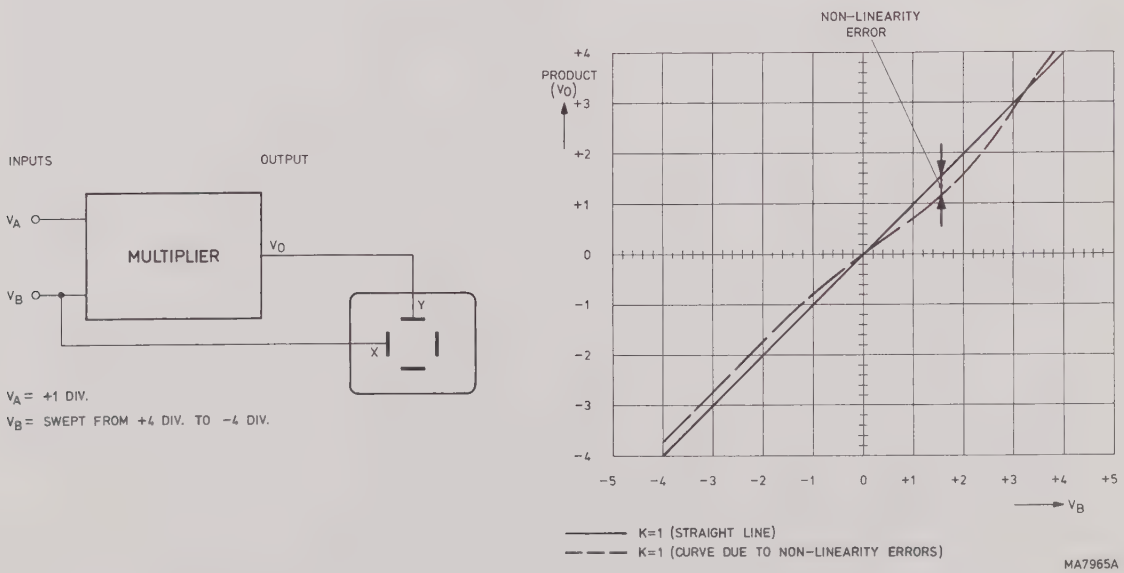


Fig. 1.9. Non-linearity

Non-linearity is the peak deviation of (AxB) = f (B) from the best straight line. It is expressed as a percentage of full screen deflection.

1.3.9. Feed-through

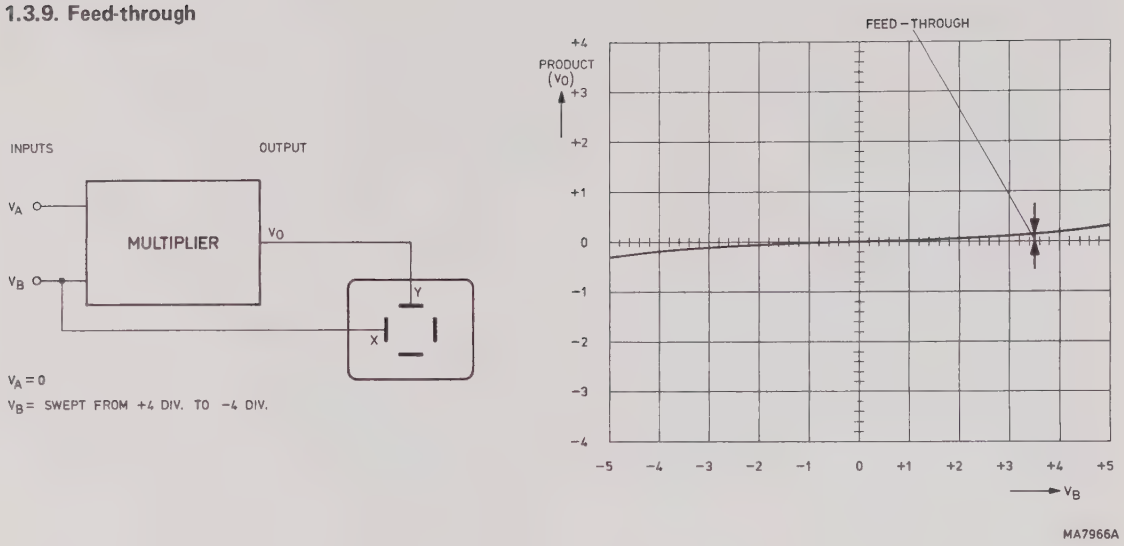


Fig. 1.10. Feed-through

Feed-through is the AC voltage at the multiplier output when after input off-set balancing, one input is held at zero and a maximum signal is applied to the other.

1.3.10. Propagation delay

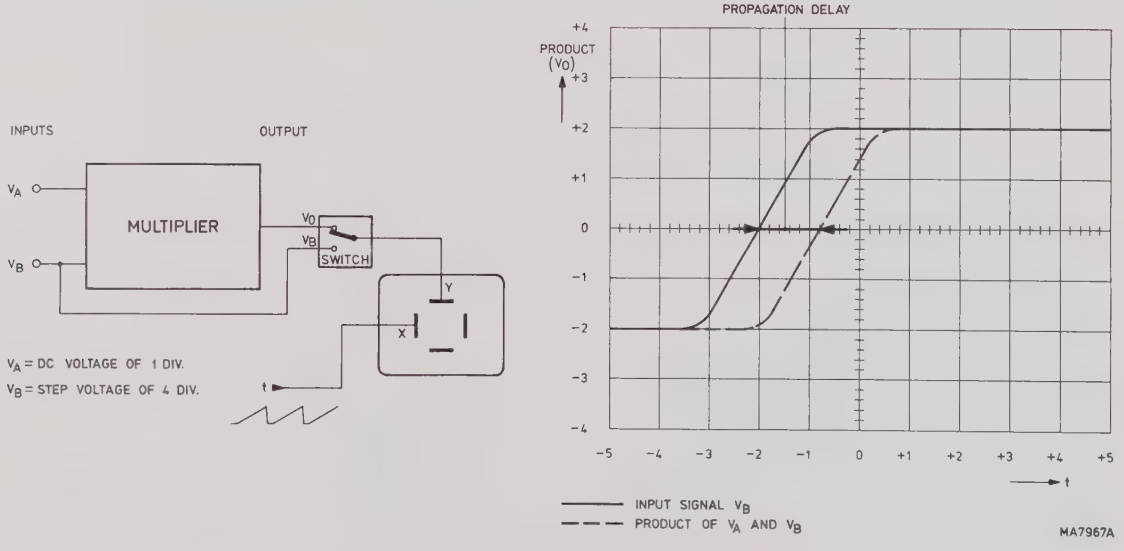


Fig. 1.11. Propagation delay

The propagation delay is the delay between input and output signals caused by the multiplier in processing the input signals.

1.3.11. Noise

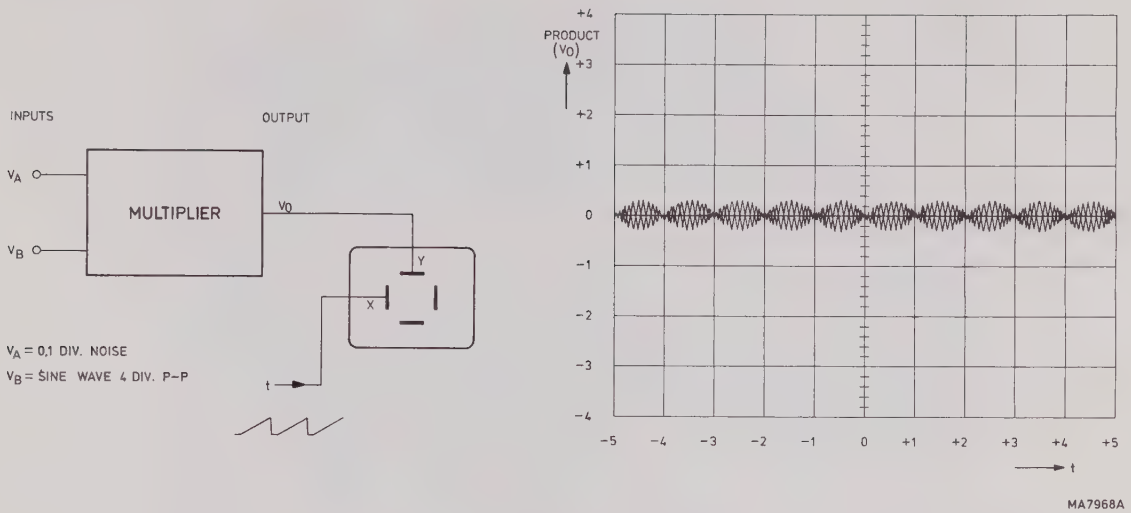


Fig. 1.12. Noise

The multiplier circuit produces no appreciable noise. However, an input voltage of A divisions at one channel will multiply the noise present at the other channel.
This can cause modulation and thus a corrugated base line.

1.3.12. Input dynamic range

The maximum signal which can be applied to inputs A and B without impairing linearity.

1.3.13. Output dynamic range

The maximum signal which can occur at the output without impairing linearity.

Fig. 2.1. Front cover

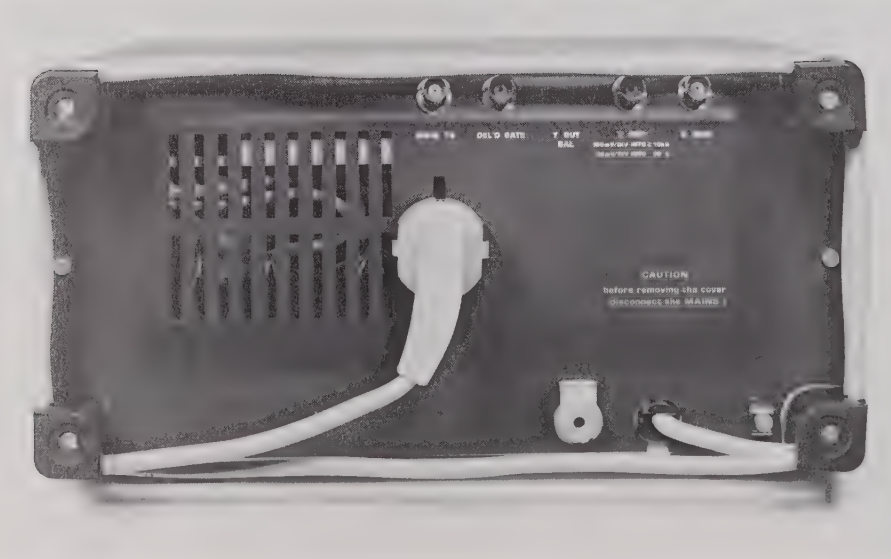


Fig. 2.2. Rear view of the instrument

2. Directions for use

2.1. INSTALLATION

Before any other connection is made, the protective earth terminal shall be connected to a protective conductor (see section EARTHING).

Warning: The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts, and also accessible terminals may be live.
The instrument shall be disconnected from all voltage sources before any adjustment, replacement or maintenance and repair during which the instrument will be opened.
If afterwards any adjustment, maintenance or repair of the opened instrument under voltage is inevitable, it shall be carried out only be a skilled person who is aware of the hazard involved.
Bear in mind that capacitors inside the instrument may still be charged if the instrument has been separated from all voltage sources.

2.1.1. Removing and fitting the front cover

Removing: – Turn the knob in the centre of the cover a quarter of a turn anti-clockwise to position UNLOCKED.
– Take the cover off.

Fitting: – Turn the knob to the UNLOCKED position.
– Fit the cover over the front of the oscilloscope.
– Press the knob and turn it a quarter of a turn clockwise to the LOCKED position.

Remark: The handle can be rotated if the push-buttons on its bearings are depressed.

2.1.2. Mains adjustment and fuse

The ability of the instrument ot operate at any mains voltage between 90 and 264 Va.c., obviates the need of adaption to the local mains voltage.
The fuse holder which is mounted on the rear panel carries a 2 A delayed action fuse. The use of repaired fuses and the short-circuiting of fuse holders is prohibited.

2.1.3. Earthing

In the interests of safety, the oscilloscope must be connected to earth via the rear earthing terminal (identified by the symbol ⏚) or via the mains lead, provided that the supply socket is equipped with an earth connection. Care must be taken that the earth line to the oscilloscope is not interrupted due to the use of an extension lead or device which is not fitted with an earth conductor.

2.1.4. Switching on

The POWER switch is incorporated in the graticule ILLUMination control on the front panel, immediately below the screen bezel. The oscilloscope must never be switched on whilst any circuit board or block has been removed.
Never remove a circuit board or block until at least one minute after the oscilloscope has been switched off.

Fig. 2.3. Front view of the instrument

2.2. OPERATING INSTRUCTIONS

Before switching on, ensure that the oscilloscope has been correctly installed in accordance with section 2.1. INSTALLATION and that the precautions outlined have been observed.

2.2.1. Controls and sockets (Fig. 2.3.)

2.2.1.1. Vertical channels

A/ALT/CHOP/ADD/MULT/B	Display-mode controls; 6-way push-button switch.
A depressed	Vertical deflection is achieved by the signal connected to the input of channel A.
ALT depressed	The display is switched over from one vertical channel to the other at the end of every cycle of the time-base signal.
CHOP depressed	The display is switched over from one vertical channel to the other at a fixed frequency.
ADD depressed	Vertical deflection is achieved by the sum signal of channels A and B.
MULT depressed	Vertical deflection is achieved by the product signal of channels A and B.
B depressed	Vertical deflection is achieved by the signal connected to the input of channel B. If no push-button is depressed, the instrument operates in the ALT mode.
MULT and B depresses simultaneously	The display is switched between MULT and B in the chop or alt mode depending on Time/div. setting
POSITION	Continuously variable control giving vertical shift of the display.
NORM/INVERT	2-Way push-button switch for the inversion of the signal polarity. No push-button depressed has the same effect as the NORM button depressed.
AMPL.	Step control of the vertical deflection coefficients; 9-way switch.
AMPL./CAL. (blue)	Continuously variable control of the vertical deflection coefficients. In the CAL. position the deflection coefficient is calibrated.
BAL (screw-driver operated)	Continuously variable control of the direct voltage balance of the vertical amplifiers.
GAIN (screw-driver operated)	Continuously variable control of the overall gain of the vertical channels.
AC/0/DC	Signal coupling; 3-way push-button switch.
AC depressed	Coupling via a blocking capacitor
0 depressed	Connection between input circuit and input socket is interrupted and the amplifier input is earthed
DC depressed	Direct coupling No button depressed has the same effect as the AC button depressed.
A 1 MOhm - 15 pF	BNC input socket for channel A
B 1 MOhm - 15 pF	BNC input socket for channel B
GAIN (screw-driver operated)	Continuously variable control of the vertical gain in the MULTIPLIER mode
ZERO A (screw-driver operated)	Continuously variable control of the off-set voltage correction in channel A (multiplier)
ZERO B (screw-driver operated)	Continuously variable control of the off-set voltage correction in channel B (multiplier)

2.2.1.2. Horizontal channel

DEL'D TB - ALT. TB - EXT. X DEFL - MAIN TB	Horizontal-deflection controls; 4-way push-button switch
DEL'D TB depressed	The horizontal deflection voltage is supplied by the delayed time-base generator.
ALT. TB	The horizontal display is switched over from the main time base to the delayed time base at the end of every cycle of the main time base generator.
EXT. X DEFL depressed	Horizontal deflection is achieved by an external signal applied to the input socket of the horizontal amplifier, by the channel A signal, by the channel B signal, the composite signal or by a mains-frequency signal.
MAIN TB depressed	The horizontal deflection voltage is supplied by the main time-base generator. A part of the trace is intensified (except in position OFF of the TIME/DIV switch of the delayed time-base generator). No button depressed has the same effect as the MAIN TB button depressed.
POSITION TB MAGN	Continuously variable control giving horizontal shift of the display; incorporates a push-pull switch which increases the horizontal deflection coefficient by a factor 10. A pilot lamp labelled x 10 lights up when the magnifier is in operation.
X AMPL/HOLD OFF	Continuously variable control of the horizontal deflection coefficients in case of external X deflection. In case of X deflection by the main time base, this control can be used to increase the sweep hold-off time.
TRACE SEP. (screw-driver operated)	Continuously variable control of the vertical space between the two time-base displays in the ALT. TB mode.

2.2.1.3. Main time-base generator

LEVEL SLOPE	Continuously variable control to select the level of the triggering signal at which the time-base generator starts. This control incorporates a push-pull switch which enables choice of triggering on the positive- or negative-going edge of the triggering signal.
NOT TRIG'D	Pilot lamp which lights up when the time-base generator is in waiting position.
AUTO - TRIG - SINGLE	Trigger-mode controls; 3-way push-button switch.
AUTO depressed	The main time-base generator is free-running in the absence of triggering signals.
TRIG depressed	The time-base generator is normally triggered.
SINGLE depressed	After operating the SINGLE button, the time-base generator runs only once upon receipt of a trigger pulse. If no button is depressed, the instrument operates in the SINGLE mode.

TIME / DIV or DELAY TIME	Time-coefficient control of the main time-base; 23-way rotary switch.
TIME/DIV - CAL (blue)	Continuously variable control of the time coefficient of the main time-base. In the CAL position the time coefficient is calibrated.
DC - LF - HF	Trigger coupling; 3-way push-button switch.
DC	Triggering signals are direct-coupled.
LF	Coupling via low-pass filter for frequencies up to 30 kHz (for external triggering via band-pass filter of 10 Hz - 30 kHz).
HF	Coupling via a high-pass filter for frequencies higher than 30 kHz. No push-button depressed has the same effect as button DC depressed.
TRIG or X DEFL	Trigger source or external X deflection selector; 4-way push-button switch.
A	Internal triggering or X deflection signal derived from channel A.
B	Internal triggering or X deflection signal derived from channel B.
COMP (A and B depressed simultaneously)	Internal triggering or X deflection signal derived from channel A and B.
EXT	Triggering on external signal connected to the adjacent 1 MOhm-15 pF socket. When the EXT X DEFL button of the horizontal deflection controls is depreseed, this socket is connected to the input of the horizontal amplifier.
MAINS	Triggering or X deflection signal derived from an internal voltage with the mains frequency. No push-button depressed has the same effect as button A depressed.
1 MOhm - 15 pF	BNC socket for external triggering or horizontal deflection.

2.2.1.4. Delayed time-base generator

DELAY TIME	Continuously variable control of the delay time, operating together with the TIME/DIV controls of the main time-base generator.
LEVEL SLOPE	Continuously variable control to select the level of the triggering signal at which the delayed time-base generator starts. This control incorporates a push-pull switch which enables choice of triggering on the positive- or negative-going edge of the triggering signal.
STARTS - TRIG	Choice of the starting point of the delayed time-base generator after the delay time; 2-way push-button switch.
STARTS	The delayed time-base generator is started immediately after the delay time.
TRIG	The delayed time-base generator starts after the delay time upon receipt of a trigger pulse. No push-button depressed has the same effect as the STARTS button depressed.
TIME/DIV	Time-coefficient control of the delayed time-base; 23-way rotary switch. Incorporates an OFF position in which the delayed time-base generator is switched off.
TIME/DIV - CAL (blue)	Continuously variable control of the time coefficient of the delayed time-base generator. In the CAL position the time coefficient is calibrated.

DC - LF - HF	Trigger coupling; 3-way push-button switch.
DC	Triggering signals are direct-coupled.
LF	Coupling via low-pass filter for frequencies up to 30 kHz (for external triggering via band-pass filter of 10 Hz to 30 kHz).
HF	Coupling via a high-pass filter for frequencies higher than 30 kHz. No button depressed has the same effect as the DC button depressed.
A - B - EXT	Trigger source control; 3-way push-button switch.
A	Internal triggering signal derived from channel A.
B	Internal triggering signal derived from channel B.
EXT	Triggering on an external signal connected to the adjacent 1 MOhm - 15 pF socket.
	No button depressed has the same effect as the A button depressed.
1 MOhm - 15 pF	BNC input socket for external triggering signal.

2.2.1.5. Cathode-ray tube

ILLUM POWER	Continuously variable control of the graticule illumination; incorporates mains switch. Pilot lamp indicates the ON state.
INTENS	Continuously variable control of the trace brilliance.
FOCUS	Continuously variable control of the electron-beam focusing.

2.2.1.6. Miscellaneous

CAL	Output socket on which a square-wave voltage of 3 V_{p-p} and a current of 6 mA at a frequency of 2 kHz are available. Amplitude accuracy: ± 1 %. Frequency accuracy: ± 2 %. The output is protected against continuous short-circuits.
BEAM LOCATE	Push-button to enable a trace to be readily located on the screen by reducing the deflection coefficients.
PROBE POWER	Power socket for active accessories; supplies +24 V and −24 V.
⏚	Measuring-earth socket.
Rear sockets	
MAIN TB	Output socket on which the sweep is available at 0...+5 V_{p-p}.
DEL'D GATE	Output socket on which a square wave voltage of 6 V_{p-p} pos. is available during the delayed sweep.
Y Out	Output socket which gives Y out at 50 mV/div at 50 Ω or 100 mV/div at ⩾ 10 kΩ.
Y OUT BAL	Controls the DC level of Y OUT.
Z Mode.	Blanking or unblanking of the trace, visible modulation up to 10 MHz.

2.2.2. Preliminary settings

As the following settings are identical for both vertical channels, only the procedure for channel A has been indicated.

2.2.2.1. Adjusting the d.c. balance

- Operate push-button A of the display-mode controls.
- Operate push-button AUTO of the trigger-mode controls.
- Operate push-button MAIN TB of the horizontal deflection controls.
- Set the AMPLitude switch to 5 mV and the continuous control to CALibrated.
- Centre the trace with the POSITION controls.
- Set the INTENSity and FOCUS controls for a sharp, well-defined trace.
  The controls not mentioned may occupy any position.
- Check that the trace does not jump when the input coupling switch is switched between the DC and O positions.
  If necessary, readjust the BALance control on the front panel immediately below the AMPLitude control.

2.2.2.2. Adjusting the gain

Unless otherwise stated, the controls occupy the same position as in the previous adjusting procedure.
- Set the AC-0-DC switch to DC.
- Set the AMPLitude switch to .5 V and the continuous control to CALibrated.
- Connect the CALibration socket to the A input socket.
- Check that the trace height is exactly 6 divisions.
  If necessary, readjust the GAIN control on the front panel, immediately below the AMPLitude switch.

2.2.3. Inputs A and B and their possibilities

The oscilloscope has been provided with two identical channels, each of which can be used for either Y/T measurements in combination with one or both time-base generators, or XY measurements in combination with the external horizontal channel.

2.2.3.1. Y/T Measurements

To display one signal, either of the two vertical channels can be selected by operating either push-button A or push-button B of the display-mode controls.
When push-button ALT or CHOP is depressed, two different signals can be displayed simultaneously. The Y deflection coefficient and the polarity can be selected for each channel individually. When the ALT button is operated, the display is switched over from one channel to the other at the flyback of the time-base signal. Although the ALTERNATE mode can be used at all sweep speeds of the time-base generator, the CHOPPED mode will give a better display quality for long sweep times, because during these long sweep times the alternate display of the two input signals is clearly visible to the eye.

In the CHOPPED mode, the display is switched over from one channel to the other at a fixed frequency.
If push-button ADDED of the display-mode switch is operated, the signal voltages of both vertical channels are added. Depending on the positions of the polarity switches, either the sum or the difference of the input signals is displayed. The ADDED mode also enables differential measurements. With these measurements advantage is taken from the common mode rejection in the ADDED position. When the polarity switches of both channels are set to opposite positions, the common mode parts of the signals on sockets A and B will undergo a very slight amplification only, with respect to the differential mode parts.

2.2.3.2. XY Measurements

If push-button EXT X DEFL of the horizontal-deflection controls is operated, the time-base generators are switched off. Push-button A of the TRIG OR X DEFL controls enables a signal applied to the A channel to be used for horizontal deflection. The AC/0/DC switch and the step attenuator of channel A remain operative.
Continuous control of the deflection coefficients is possible with the X DEFL/HOLD OFF control and horizontal trace shift with the X POSITION control.

Vertical channel B may also be used for X deflection.
To this end, the B botton of the TRIG OR X DEFL controls is depressed.
The composite signal of A and B may also be used for X deflections by depressing the A and B button simultaneously.

It is also possible to use an internal voltage at the mains frequency or a signal applied to the EXT socket at the bottom right-hand side of the front panel for X deflection, after depressing the relevant push-button of the TRIG OR X DEFL controls. In these modes the trace width can be controlled with the X DEFL/HOLD OFF potentiometer.
With this potentiometer in its CAL position, the deflection coefficient for external signals is 300 mV/DIV.
The external signal can be either d.c or a.c. coupled (lower frequency limit 10 Hz) by depressing either the DC or the LF/HF push-button of the trigger coupling controls of the main time-base.

2.2.3.3. AC/0/DC switch

The signal under observation is applied to input socket(s) A (B) and the AC/0/DC switch is set to either AC or DC. As the vertical amplifier is d.c. couplied, the full band-width of the instrument is available and d.c. components are displayed as trace shifts in the DC position of the AC/0/DC switch.
This may be inconvenient when small signals superimposed on high d.c. voltages must be displayed. Any attenuation of the signal will also result in attenuation of the small a.c. component. The remedy is to use the AC position of the input switch, which employs a blocking capacitor, to suppress the d.c. level.
Some pulse droop will occur when l.f. square-wave signals are displayed.

The 0 position interrupts the signal and earth the amplifier input for quickly determining the zero level.

2.2.4. Using the multiplier

The signals to be multiplied must be applied to input sockets A and B.

2.2.4.1. Dynamic range

Both multiplicants A and B must be within the dynamic range of the multiplier and preamplifier circuits. As an overload condition for these circuits might not be noticed in the displayed product, care must be taken to keep each of the input signals within the specified dynamic range, allowing for a maximum amplitude of 8 $div_{p\text{-}p}$.

For the displayed product again a maximum amplitude of 8 $div_{p\text{-}p}$ is specified. If the output maximum is exceeded, one of the input signals must be reduced in amplitude.

2.2.4.2. Multiplier balance

When either A or B is multiplied by 0 (zero), the product must be zero. Offset voltages at the multiplier inputs may still cause some deflection on the screen. These offset voltages must be reduced to a minimum by using the following procedure:

- Allow a warm-up period of at least 15 minutes, preferably 30 minutes.
- Apply an a.c. signal with an amplitude within the specified dynamic range to both input A and input B.
- Depress push-button MULT of the display-mode controls.
- Depress push-button 0 of the channel A signal coupling controls.
- Depress push-button AC of the channel B signal coupling controls.
- Minimize the deflection by means of the 0xB potentiometer without changing the attenuator setting.
- Depress push-button AC of the channel A signal coupling controls.
- Depress push-button 0 of the channel B signal coupling controls.
- Minimize the deflection by means of the 0xA potentiometer without changing the attenuator setting.

2.2.4.3. Multiplier gain

- Set both AMPL switches to 10 mV/DIV and the vernier controls to CAL.
- Depress the DC push-button of the signal coupling controls of both channels.
- Apply a sine wave signal of 40 $mV_{p\text{-}p}$, frequency 50 kHz, to the channel A input socket.
- Apply a d.c. voltage of 10 mV to the channel B input socket.
- Adjust the MULTIPLIER GAIN control on the front panel for a trace height of 4 div.

2.2.4.4. Multiplier output level

The multiplier output signal is displayed via the A channel. The displayed product will normally have a d.c. component, also if both input signals consist of a.c. components. Therefore, it is important to know the zero level of the displayed product. The d.c. zero line can be shifted to the most convenient place on the screen by means of the channel A POSITION control, if the 0 push-button of the signal-coupling controls has been depressed.

2.2.4.5. Multiplier output connector

The multiplier output signal is available at a BNC connector labelled Y OUT at the rear of the instrument. The output signal (being the instantaneous value of the displayed product) is calibrated in terms of screen deflection: one division provides 100 mV into a high-ohmic load ($\geqslant$ 10 kOhm) or 50 mV into 50 Ohm.

2.2.5. Triggering

If a signal must be displayed, the horizontal deflection must always be started on one fixed point of the signal in order to obtain a stationary display. The time-base generator is, therefore, started by narrow trigger pulses formed in the trigger unit and controlled by a signal originating from the vertical input signals, an internal voltage at mains frequency or an external source.

2.2.5.1. Trigger coupling

Three different trigger-coupling methods can be chosen with the DC/LF/HF switch. In the HF and LF positions, the transfer characteristic is limited.
In position DC the trigger signal is passed unchanged.
In position LF, a 0 Hz (10 Hz for external triggering) to 30 kHz band-pass filter is inserted. This position can be used to reduce interference from noise.
In position HF, a 30 kHz high-pass filter is inserted.
This position can be used to reduce interference from e.g. hum.

2.2.5.2. Selecting the trigger source and setting the trigger level

The trigger signal is obtained from channel A (button A depressed), channel B (button B depressed), the COMPosite A and B signal (buttons A and B simultaneously depressed), an external source (button EXT depressed) or from an internal voltage at mains frequency (button MAINS depressed).
The trigger signal is not affected by the continuous AMPLitude control. Depending on the LEVEL setting the trigger start point is selected. (see fig. 2.4)
This means that, with the aid of the LEVEL control, it is possible to scan the shape of the trigger signal.
The LEVEL potentiometer is combined with a push-pull switch which allows selection of the trigger SLOPE.

2.2.5.3. Automatic triggering

When the AUTOmatic button of the AUTO-TRIG-SINGLE switch is operated, and if there are no trigger pulses available, the time-base generator is automatically free-running.
The trace is, therefore, always visible. The AUTOmatic mode can be used in all cases where also the TRIG mode is usable, except with signal frequencies lower that 20 Hz or pulse trains with an off time exceeding 50 ms.
As soon as trigger pulses are available, the free-running state of the time-base generator is automatically terminated and the time-base generator is triggered again as described in sections 2.2.5.1. and 2.2.5.2.
When the TRIGgered or SINGLE button is operated, the auto-circuit is switched off. The LEVEL setting can also be used in the AUTOmatic mode.

2.2.5.4. SINGLE sweep triggering

When effects which occur only once have th be observed (usually photographed), it is often desirable to ensure that only one sawtooth is generated, even though several trigger pulses might be produced after the phenomenon of interest. Of course, the single sawtooth in question must be triggered by a trigger pulse. To this end, the SINGLE button must be pressed. The first trigger pulse that appears after the button has been released will start the time-base generator.
The time-base generator is then blocked until the SINGLE button is pressed again. The NOT TRIG'D lamp will light up as soon as the SINGLE button has been released, until the trigger pulse arrives.

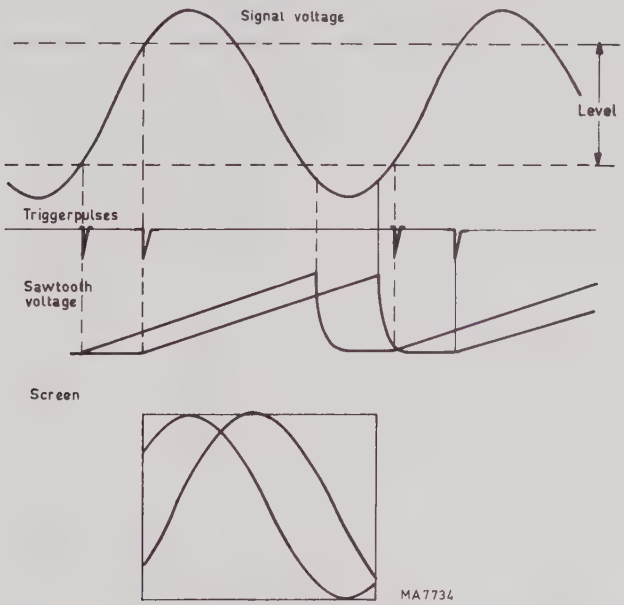


Fig. 2.4. Scanning the waveform by means of the LEVEL potentiometer

2.2.6. Time-base MAGNifier

The time-base magnifier is operated by a push-pull switch incorporated in the horizontal-POSITION control. If this switch is pulled to position x10, the sweep speeds of the main time-base generator are increased by a factor of 10. Thus, the portion of the signal displayed over one division in the x1 position (T B MAGNifier depressed), will occupy the full width of the screen in the x10 position.
Any portion of the trace can be brought on to the screen by the horizontal-POSITION control for scrutinisation. In the x10 position, the time coefficient is determined by dividing the indicated TIME/DIV value by 10.

2.2.7. Use of the delayed time-base

The delayed time-base can be used for the accurate study of complex signals. When push-button STARTS of the STARTS/TRIG controls is operated immediately after the delay-time, the delayed-time base starts (TIME/DIV switch not at OFF), and the delayed signal is intensified in the MAIN TB position of the horizontal deflection controls. The DELAY TIME control enables this intensified portion to be shifted along the time axis. The duration of the intensified portion, its length, can be controlled in steps and continuously by means of the TIME/DIV controls of the delayed time-base generator. When push-button DEL'D TB of the horizontal deflection controls is operated, the intensified portion occupies the full width of the screen. In the DEL'D TB position, the delay time, (i.e. the interval between the starting point of the main time-base and the starting point of the delayed time-base) is determined by the settings of the main TIME/DIV controls and the DELAY TIME control.

If the TRIG button of the STARTS/TRIG controls is operated, the delayed time-base is started by the first trigger pulse that occurs after the selected delay time. This trigger pulse is supplied by the trigger unit of the delayed time-base generator. This position is used when time jitter would otherwise give a blurred image of the detail under observation. This time jitter could be part of the signal being investigated or, at extreme magnifications, originate in the time-base circuits.

2.2.8. Use of the ALTernate TB

The PM 3265 is equipped with display switching. This offers the instrument user a simultaneous display of the signal on the two time scales provided by the main time-base and by the delayed time-base.
Detailed examination of a certain portion of the main time-base display is enabled by expanding the time interval of interest by means of the delayed time-base. Expansion is achieved by selecting a correspondingly faster sweep for the delayed time-base TIME/div. control. Positioning of the time interval is set by the DELAY TIME potentiometer.

The part of the signal under detailed observation by the delayed time-base remains as an intensified portion of the main time-base display. This not only facilitates the location of the required detail during dialling but also serves as a visual indication of which portion of the overall trace is being examined. One can immediately correlate the detail with the overall signal, which may be extremely complex, without the necessity of switching between MAIN TB and DEL'D TB.

Vertical shift between the two time-base displays is continuously variable with the TRACE SEParation control.

Service manual

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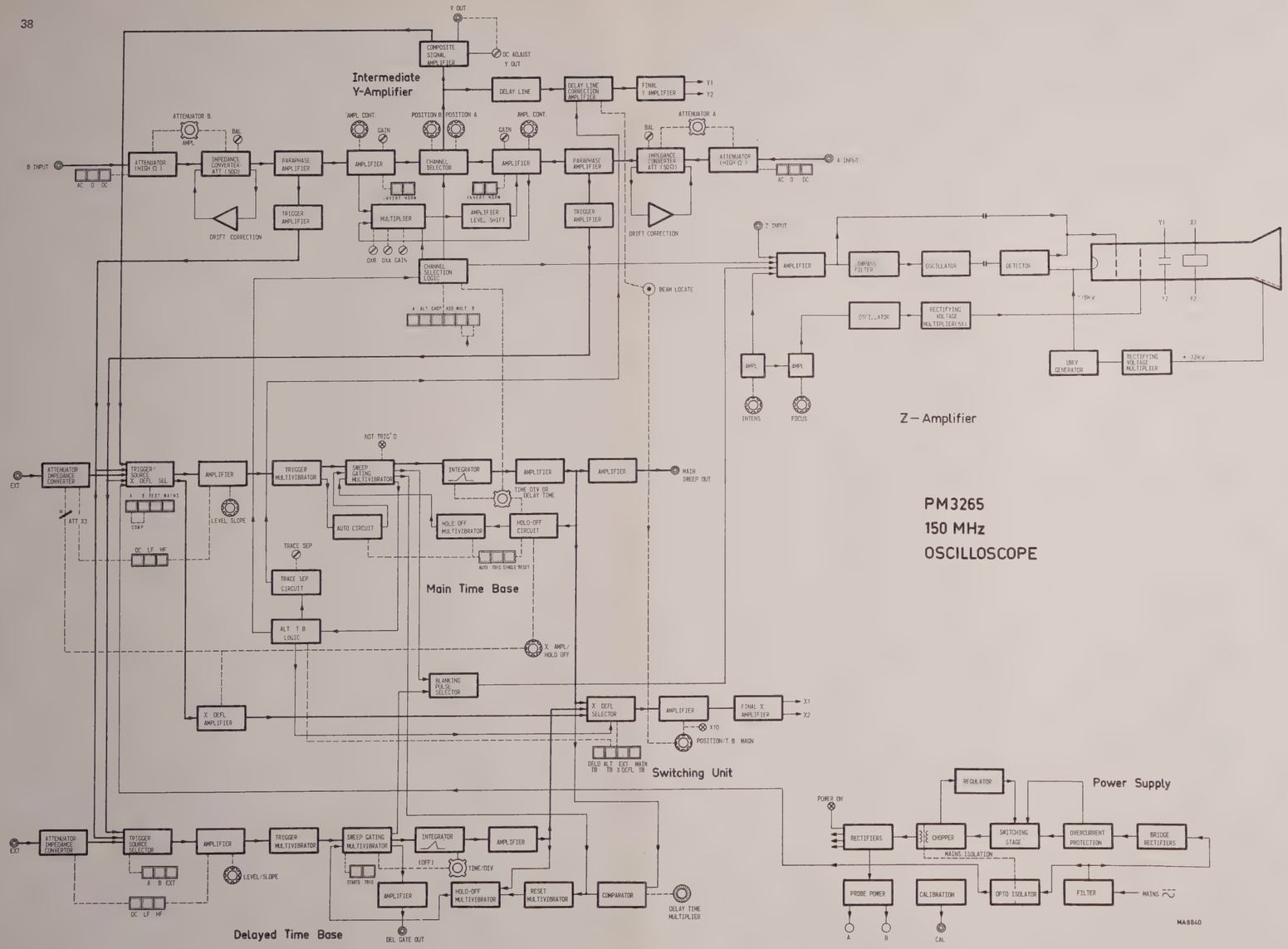


Fig. 3.1. Block diagram

3. Service manual

3.1. DESCRIPTION OF THE BLOCK DIAGRAM

3.1.1. General information

The PM 3265 oscilloscope comprises the following parts:

– a dual-channel vertical system with signal multiplication facility.
– a main time-base
– a delayed time-base
– a switching unit
– an X amplifier
– a Z amplifier
– a c.r.t. circuit
– a stabilized power supply

3.1.2. Dual-channel vertical system

Both vertical channels contain identical circuits. An input signal to one of the channels is, via a coupling switch AC/0/DC, applied to the input attenuator. In the AC position of the coupling switch there is a capacitor in the signal path. In the DC position the coupling is direct. If the coupling switch is set to the 0 position, the connection between the input socket and the attenuator input is interrupted, the latter being earthed.

The input attenuator, which is controlled by the AMPL switch, enables the adjustment of the vertical-deflection sensitivity in calibrated steps.

The attenuator is followed by a split-band low-drift impedance converter, which gives the circuit a high input impedance. The impedance converter also contains a voltage divider which works in conjunction with the input attenuator.
The att. balance is set by compensating for the d.c. offset voltage of the impedance converter by means of the BAL potentiometer on the front panel.

The signal that leaves the impedance converter on a 50 Ohm level is applied to a paraphase amplifier where it is transformed into a push-pull signal. The paraphase amplifier has two outputs. From one of these outputs the signal is applied to a trigger pre-amplifier, and, from the other one to a second amplifier stage. This stage comprises the switch NORMAL/INVERT by means of which the phase of the signal can be inverted, and a CONT. AMPL. potentiometer which allows the overall gain of the channel to be set between the input attenuator steps. The second amplifier stage comprises also a GAIN preset potentiometer to allow calibration of the input step attenuator.
The signals to be multiplied, are taken out of these amplifier stages in channels A and B, are multiplied in the multiplier circuit and the resulting signal is amplified by the level-shift amplifier and reinserted into the amplifier of channel A.

The following stage is a channel selector which either blocks or passes the signal as dictated by the channel selector logic. The channel selector also comprises the controls for vertical trace positioning.
In the A, B, Multiply or ADD modes the channel selector logic is controlled by means of fixed levels and in the ALT, CHOP, Multiply and B together mode, it is pulse-controlled. In the ALT mode those pulses are supplied by the sweep-gating multivibrator of the main time-base generator during the flyback of the sweep, so that alternately the complete signals of channel A and channel B are displayed.
If ALT. TB is depressed, four traces can be displayed in the sequency: A-MTB, A-DTB, B-MTB and B-DTB.
In the CHOP mode the drive pulses are generated by an oscillator which supplies a fixed frequency of approximately 1 MHz.
Those pulses cause the electronic switches in the channel selector to be successively opened and closed so that successively parts of the signal of channel A and of channel B are displayed. If Multiply and B are depressed simultaneously, switching is done in the chop or alternate mode, depending on the position of the Time/div. switch.

After the channel selector, the following circuits are common to both vertical channels.
A composite signal amplifier for trigger purposes and, at the same time, for the external Y output, a delay line that delays the vertical signals to such an extent that the steep leading edges of fast signals are still displayed, a correction circuit in which the losses caused by the delay line are compensated for, and a final output stage which feeds the signals to the vertical-deflection plates.

3.1.3. Time bases

3.1.3.1. Main time-base

The trigger source/X deflection selector receives its signal from one of the vertical channels or both (COMPOSITE) from the external input or from the power supply (MAINS). One of those signals can be selected by operating one of the controls incorporated in this stage.

From the selector stage the signal is fed to either the X amplifier for horizontal deflection, or the trigger amplifier for starting the time-base generator. This amplifier contains the controls for trigger-level adjustment, slope selection and DC/LF/HF selection. The slope selector allows the polarity of the trigger signal to be inverted, enabling triggering on the positive as well as on the negative slope.

The three modes of operation of the main time-base are determined by the three-position switch AUTO/TRIGG/SINGLE.
In the AUTO mode, the automatic free-run circuit is operative when triggering pulses are absent. Thus a trace, though not necessarily a stationary one, is always displayed even though the trigger controls may not be correctly adjusted. In this way, correct adjustment of the oscilloscope trace is greatly facilitated. However, when trigger pulses are present the circuit reverts to the normal triggered mode. If trigger pulses disappear, the time-base free-runs after a lapse of approx. 50 ms. In the TRIGG. mode, a display is present only when suitable trigger pulses are available.
In the SINGLE mode, events that occur only once can be observed and photographed if necessary. It is often desirable to ensure that only one sweep is generated, even though other trigger pulses might follow the phenomenon of interest. In this mode, after the trigger pulse has initiated the main time-base to produce one sweep, the circuit is unaffected by further trigger pulses until it is reset for the next event by operating the reset push-button.
The sweep-gating multivibrator starts and stops the integrator which delivers the sawtooth signal required for the horizontal deflection. The integrator comprises the charging capacitors and resistors selected by the TIME/DIV switch in order to set the time coefficients in calibrated steps. Continuous control of the time coefficients is obtained by varying the charging current of the time determining capacitors by means of the TIME/DIV potentiometer.
The amplified output signal of the integrator is fed to the X deflection selector, the hold-off multivibrator and the comparator which is part of the delayed time-base unit. The hold-off multivibrator switches back the sweep-gating multivibrator and blocks its input during the flyback of the sawtooth signal.

3.1.3.2. Delayed time-base

The saw-tooth voltage derived from the main time-base generator is passed to a comparator where it is compared with an accurately adjustable d.c. voltage. The comparator output voltage is then pulse shaped by a reset multivibrator to provide the required delayed pulse. As indicated in the relevant waveforms of Fig. 3.2, the pulse shaper output voltage drops to its original value at the end of the forward sweep of the main saw-tooth voltage.

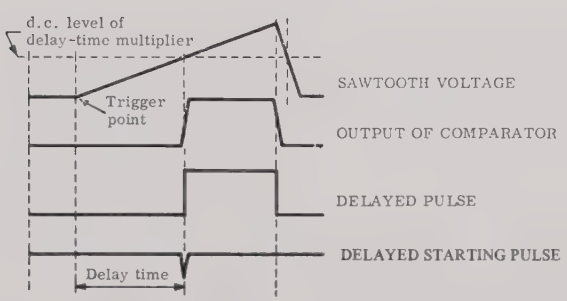


Fig. 3.2. Derivation of Delayed Pulse

The delayed pulse is fed to the delayed time-base generator which then initiates a saw-tooth voltage and an unblanking pulse, both of which are fed to the c.r.t. The time relationship between these waveforms is shown in Fig. 3.3.

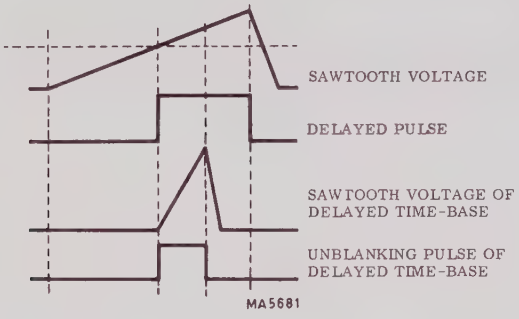


Fig. 3.3. Delayed Time-Base Waveforms

With the DELAY TIME switch in the START position, the delayed time-base starts immediately on receipt of a pulse from the reset multivibrator.

Triggered Operation of the Delayed Time-Base

With the DELAY TIME switch in the TRIGG. position, the delayed starting pulse prepares the time-base for the normal triggered mode of operation. The next trigger pulse from the internal trigger unit or from an external source (dependent on switch setting) arriving after the set delay time actuates the delayed time-base, which is then locked to this trigger signal. The waveforms of Fig. 3.4 illustrate this gating procedure. The total delay is now the sum of the set delay time (i.e., the product of the values indicated by the DELAY TIME and DELAY TIME MULTIPLIER controls) and the extra delay indicated in Fig. 3.4.

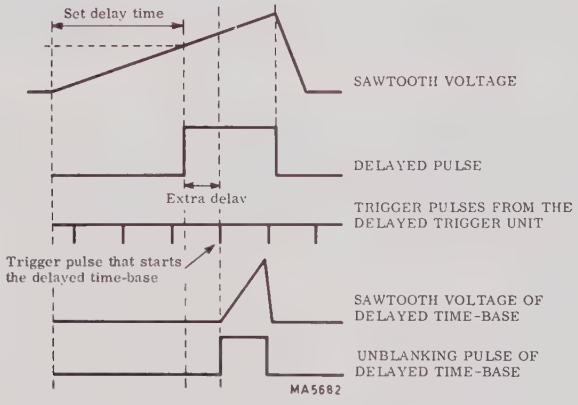


Fig. 3.4. Gating waveforms of Delayed Time-base

HORIZONTAL DISPLAY MODES

A choise of five different modes of display is possible by means of the X DEFL. selector switch and the DTB on/off switch.

MAIN T.B. with DTB in OFF. position

When the X DEFL. switch is set to MAIN T.B., a saw-tooth voltage derived from the main time-base generator is fed via the horizontal amplifier to the horizontal deflection plates of the cathode ray tube.
In addition, the gating pulse from the main time-base is applied to the control grid (Wehnelt cylinder) of the c.r.t. via the unblanking circuit in order to intensify the trace during the sweep.

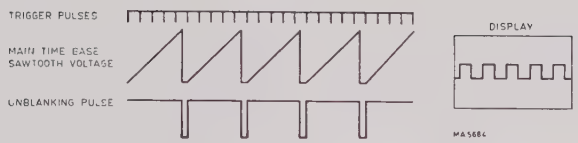


Fig. 3.5. Main Time-Base Display

MAIN T.B. with DTB switched in

When the X DEFL. switch is set to MAIN T.B. the saw-tooth voltage derived from the main time-base generator is again fed to the c.r.t. via the time-base amplifier. However, in these positions of the DTB switch, the gating pulses from the main time-base and the delayed time-base are combined and applied to the control grid of the c.r.t. During the operation of the delayed time-base generator the trace undergoes extra intensification. The start of the intensified portion can be shifted by means of a ten-turn potentiometer, the DELAY TIME MULTIPLIER.

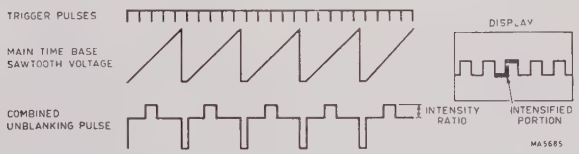


Fig. 3.6. Main Time-Base Intensified Display

DEL'D T.B.

When the X DEFL. switch is set to DEL'D T.B. the saw-tooth voltage from the delayed time-base generator is fed to the deflection plates of the c.r.t. and the gating pulse from the delayed time-base is fed to the control grid of the c.r.t. As a result, the intensified portion of the display, produced by the previous setting is now expanded to fill the entire screen.

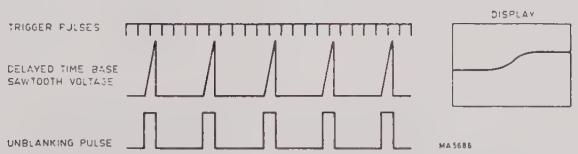


Fig. 3.7. Delayed Time-Base Display

ALT. T.B.

When the X DEFL. switch is set to ALT. T.B. an electronic switch enables the display of Fig. 3.6 and the display of Fig. 3.7 to be alternately traced on the screen. The two displays can be separated by varying the voltage applied to the vertical amplifier, derived from the driving circuits of the electronic switch. This separation is symmetrically variable by means of the TRACE SEPARATION control.

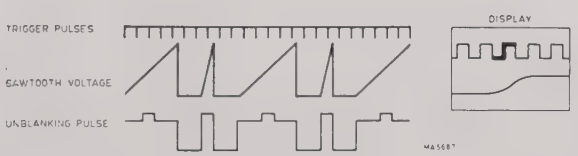


Fig. 3.8. Alternate Time-Base Display

EXT. X DEFL.

When the X DEFL. switch is set to EXT., this permits an external voltage to be applied to the X pre-amplifier to provide horizontal deflection via the time-base amplifier.
This facility can be used for XY applications, where phase relationships between the X and Y deflections above 100 kHz are not important.

3.1.4. Switching unit and X amplifier

Apart from the blanking pulse selector and the X deflection selector, the switching unit comprises an amplifier for external X deflection signals and an intermediate amplifier. The X deflection selector, couples the external X deflection signal, the output signal of the main time-base generator or the combined output signals of the main and delayed time-base generators to the intermediate X amplifier and from there via the final amplifier to the horizontal-deflection plates. The intermediate amplifier comprises the horizontal trace positioning and 10x magnification controls.

The blanking pulse selector supplies blanking pulses to the Z amplifier.
These pulses blank the trace at the end of the sweep of the main time-base and provide the extra bright-up pulse if the oscilloscope operates with a portion of the trace intensified. The blanking pulses during the switching of the traces in the chopped mode go direct from the channel selector logic to the Z amplifier.

3.1.5. Z Amplifier and c.r.t. circuit

The Z amplifier receives three input signals. One originates in the time-base generator and is, via the switching circuit, applied to the Z amplifier to blank the trace during the flyback. The second one is supplied by the channel selector logic to blank the trace during switching from channel to channel in the chopped mode. The third is the ext. Z input signal. The INTENS potentiometer determines the amount of input current fed to the Z amplifier. At the output of the amplifier, the signal is split into two parts: an d.c. part and an a.c. part.
The a.c. part is fed direct to the Wehnelt cylinder of the c.r.t. The d.c. part is modulated on to an oscillator signal and afterwards detected in a peak-detector. Both signal parts are combined again on the Wehnelt cylinder.

The focus voltage for the c.r.t. is generated in an oscillator. The output voltage of the oscillator is rectified, multiplied by a factor of 5 and applied to the focussing anode. The focussing voltage is controlled by the FOCUS potentiometer which is electronically coupled with the INTENS potentiometer. In this way, defocussing due to operation of the INTENS potentiometer is largely obviated.

The high voltage for the post-acceleration anode of the c.r.t. is supplied by a stabilized oscillator whose output voltage is rectified and multiplied by a factor of 9.

Furthermore, the c.r.t. circuitry comprises preset potentiometers for trace rotation, astigmatism, distortion and orthogonality.

3.1.6. Stabilized power supply

The mains voltage is rectified and fed to a switching voltage regulator.
The regulated voltage is fed to a 20 kHz chopper. The secundary voltages of the chopper transformer are full-wave rectified, smoothed and applied to the various circuits.
The MAINS triggering signal is taken direct from the mains and, via a photo coupler, insulated, fed to the trigger circuitry on a safe level.

The calibrator is a square-wave generator which supplies an accurate voltage and current for calibration purposes.

Probe power is supplied for two active probes.

3.2. CIRCUIT DESCRIPTION

3.2.1. Vertical Deflection System

3.2.1.1. Input attenuator

The input stage comprises two identical attenuator units A and B.
Each attenuator consists of a triple high ohmic voltage divider followed by an impedance converter. The latter consists of an a.c. path and a d.c. path which is also used in conjunction with a drift correction circuit. The impedance converter is followed by a triple low-ohmic divider and by an emitter follower stage.

The overall attenuation of the input stage is determined by the combination of the selected sections of both voltage dividers. The various combinations are selected by the position of the front panel attenuator switch SK10 in conjunction with reed relays.

The high - ohmic voltage divider sections attenuate by a factor of x1, x10 and x100, each section being switched by two reed relays. The low-ohmic divider IC102, gives attenuations of x1, x2 and x4 at outputs 2, 3 and 4 respectively. With the overall combinations of attenuation, nine Y deflection coefficients are realized from 5 mV/DIV to 2 V/DIV in a 1-2-5 sequence.

Constant input capacitance for the various attenuator positions is achieved by trimmers C102, C107 and C111. The high - ohmic voltage divider sections are made independent of the input frequency (i.e., the capacitive attenuation for a.c. signals is adjusted to the resistive attenuation for d.c. signals) by means of trimmers C101 and C109 (except for the "x1" section).

The a.c. component of the input signal is fed to the gate of TS101. The d.c. component developed across R131 is fed to input 3 of differential amplifier IC101. Part of the impedance converter output signal (emitter of TS103) is used as feedback to the other input (point 2) of IC101, controlled by the L.F. gain (R132) and the att. bal. R15.

Any d.c. drift in the attenuator circuit, for instance due to temperature changes, is fed to this differential amplifier to provide a correcting d.c. feedback voltage via pin 6 of the differential amplifier to the impedance converter.

The low-ohmic output from the impedance converter is fed to integrated circuit IC103 which comprises an emitter follower and a transistor coupled as a diode for level-shifting. The output provides a correct impedance match for the coaxial cable to the intermediate amplifier.

Input coupling switch, SK16 (pushbuttons AC-O-DC) also forms part of the input attenuator stage. When the AC position is selected, capacitor C104 is in series with the input and reduces the lower frequency limit to 10 Hz. When the DC position is selected, RE106 is energised and C104 is bypassed via resistors R109 and R111 in series. Selection of the O pushbutton energises RE108 and provides an earth path for the impedance converter input via R116. In addition, it de-energises all other attenuator reed relays and isolates any external signals applied to the Y input.

3.2.1.2. Intermediate amplifier

The intermediate amplifier also, mainly comprises hybrid integrated circuits for better temperature control and increased stability. The signal paths for channel A and channel B are identical in the input stages of the intermediate amplifier.

Amplifier I
The Y output signal from the channel A attenuator is applied via R318, part of an h.f. boost circuit TS302, to pin 12 on AMPLIFIER I (IC302). Transistors TS301 and TS303 provide constant-current sources for this integrated circuit. The RC network comprising C308, C309, C311, C314 and R319, R321, R322, corrects the h.f. response in conjunction with the preset potentiometer R323 (HF) connected to pin 14.

The NTC resistor complements the temperature coefficient of freq. bandwidth variations. The integrated circuit AMPLIFIER I has two symmetrical outputs: one to the next amplifier stage and another to the trigger amplifier, IC301. Two h.f. boost amplifiers TS304 and TS306 are provided between the outputs of AMPLIFIER I and the inputs of AMPLIFIER II.

Amplifier II

The Y signal is applied to pins 11 and 15 of AMPLIFIER II (IC304). In this amplifier, the overall gain of the channel is adjustable by the front-panel GAIN preset, R16A which is connected via the AMPL Y amplitude continuous control, R11A. Any unbalance due to re-adjustment of the GAIN preset can be compensated for by the GAIN BAL preset R311, which varies the current source TS301 of the AMPLIFIER I integrated circuit block.

The AMPL control is given a high degree of stability by applying its output to an operational amplifier (IC303) and a bridge circuit comprising transistors TS307 to TS309. Controlled by the AMPL potentiometer, the circuit sets the gain of AMPLIFIER II by means of a diode bridge between the balanced signal paths. Rotation of the AMPL control varies the dynamic resistance of the bridge circuit and, via 7 and 19, short-circuits a greater or less part of the symmetrical signal.

The d.c. unbalance is compensated for by supplying or draining current on point 5 of this hybrid circuit (IC304; for Ch. B: IC204), depending on preset potm. R220.
This current is also depending on the Y-input AMPL. vernier control, because TS308 (Ch. B: TS208) controls also TS200 and TS205.

The NORMAL/INVERT switch SK6 is connected via series resistors R354 and R357 to points 2 and 24 on AMPLIFIER II to allow the Y signal of the A channel to be inverted by transistor switching within the circuit block. Any unbalance between the two positions of this switch can be compensated for by the POL BAL preset, R353. The switching earth is derived from the SK1 MULT contact via R363 and is routed via the NORMAL/INVERT switch SK7 to ensure inversion irrespective of the position of the latter, which applies for the Multiply mode only.

Diodes GR304 and GR306 are blocked by an earth applied in the MULTIPLY mode in order to provide diode switching in AMPLIFIER II to route the A signal through the multiplier circuits as described later.

Channel selector

In all other modes, the output signal of AMPLIFIER II is routed via points 27 and 29 to points 14 and 12 of the integrated circuit IC208 (CHANNEL SELECTOR). The signals of channel B are also applied to this integrated circuit on points 27 and 29. Inputs from the channel selection logic (section 3.2.1.3.) on points 7 (A) and 4 (B) provide the control signals for determining the output signals from the CHANNEL SELECTOR to the delayline (points 22 and 19) and the COMPOSITE SIGNAL AMPLIFIER (points 24 and 17). The outputs that can be selected by the vertical mode switch are:

– channel A signal
– channel B signal
– channels A and B added, chopped or alternated
– channels A and B multiplied
– channels A and B multiplied, together with channel B displayed.

In the ADD mode, emitter-follower TS211 is conducting as the earth is removed from R283. The collector supply provides (via point 5) the extra current needed for both channels.

The front-panel POSITION potentiometers R3 and R7 provide vertical shift potentials for the A and B signal channels in the CHANNEL SELECTOR.

Composite signal amplifier

The COMPOSITE SIGNAL AMPLIFIER, integrated circuit block IC209, accepts the output signal from the CHANNEL SELECTOR and, after amplification provides two outputs. One is fed from point 19 to socket BU10 on the rear of the instrument as an external Y output. The other is fed via points 23 and 18 as a balanced composite trigger signal to the main time-base. The DC BALANCE Y OUTPUT preset R23 controls the emitter supply of one of the output transistors in the COMPOSITE SIGNAL AMPLIFIER.

Trigger amplifier

In addition to the composite trigger signals, balanced trigger signals are available for the main and delayed time-base from points 14, 15 and 11, 12 respectively of the A channel TRIGGER AMPLIFIER circuit block IC301 (IC201, B channel). The symmetry of the outputs, which are at 0 V levels, can be set by preset potentiometer R301 (SHIFT). The zero-volt level can be set by preset R304 (ZERO).

Multiplier

In the multiplier mode, signals are diverted by diode switching in AMPLIFIER II of both the A and B channels to the input of the MULTIPLIER integrated circuit block IC206. The A input is connected to points 27 and 29, and the B input connected to points 22 and 21. In the A signal path, transistors TS1605 and TS1606 are switched off and the negative blocking potentials normally applied to points 4 and 22 of AMPLIFIER II are removed. The A signals are therefore diverted via diodes in AMPLIFIER II to the input of the multiplier. Similarly, the B channel signal is diverted to the multiplier since TS1608 is non-conducting and therefore TS1607 conducts to provide diode switching potentials in the B channel AMPLIFIER II via GR1603 and GR1604.

Since TS1608 is non-conduction, TS1609 conducts and switches off emitter-follower TS1611. The emitter load resistor R1631 now absorbs current via point 24, thus compensating for the current normally fed back from the multiplier to AMPLIFIER II when the internal diodes connected to points 4 and 22 are blocked.

The multiplier principle involved is based on the property of the bipolar transistor whereby its mutual transconductance varies linearly with the emitter current. Consequently the A input voltage is applied to a voltage-to-current converter network for application to the multiplier as emitter current. The B input voltage is applied to the base of the bipolar transistor.

Front-panel presets 0xA (R6) and 0xB (R5) provide zero compensation for any offset voltages in the multiplier circuits. The GAIN preset control R4, connected via R6 and points 3 and 6, varies the bias potential on the multiplier circuit.

The multiplier part of IC206 is followed by level-shifting circuits and a cascode amplifier to provide outputs of AxB on points 14 and 12.

Amplifier III

The outputs from the MULTIPLIER are fed via resistors R266 and R268 to points 26 and 30 on AMPLIFIER III (IC207). The integrated circuit block comprises an amplifier and level-shifting stage.

Emitter-follower TS1604 absorbs current via point 8 in all other modes except the MULT mode, to maintain circuit stability.

The HF correction preset potentiometer R272 is applied via point 28 to a varicap diode in the input amplifier emitter circuit. It operates in conjunction with the correction network R391, R392, R393, C264, C266, C267 and C268 across points 27 and 29.

The outputs from AMPLIFIER III (points 14 and 12) are connected direct to points 23 and 3 on AMPLIFIER II. Here the AxB signal is amplified and passed to the CHANNEL SELECTOR.

3.2.1.3. Channel selection logic

The channel selection logic consists of digital circuits employing dual-in-line TTL integrated circuits IC1601, IC1602, IC1603 and IC1604. Vertical mode selection is made by the six-pushbutton switch SK1. Horizontal mode selection is made by the four-position switch SK2.

Positive logic is used in the digital circuits, the levels being as follows:

logic '1' = +5 V (high)
logic '0' = 0 V (low)

In the vertical channel selection circuits, logic '1' enables the A and B channels from the outputs 6 and 3 of the NAND gates IC1604.
The different functions of the logic circuits are now described according to the vertical display mode controls (SK1).

A — selects channel A only. Input 2 of flip-flop IC1603 is low, consequently output 15 is high. Input 1 to NAND gate IC1604 is therefore high thus giving a low output on pin 3 to block channel B. Output 14 of the flip-flop is low, consequently output 6 of the NAND gate is high and channel A is enabled.

B — selects channel B only. Input 3 of the flip-flop IC1603 is low, consequently output 14 is high, input 4 of NAND gate IC1604 is therefore high and the resulting low output on pin 6 blocks the A channel. Output 15 of the flip-flop is low, consequently the output on pin 3 of IC1604 is high and channel B is enabled.

ADD — adds channels A and B. Gate inputs 2 and 5 of NAND gates IC1604 are both low, consequently both outputs are high irrespective of the state of the flip-flop. Both A and B channels are therefore enabled. An earth is also removed from R283 to deliver more current via TS211 to the CHANNEL SELECTOR in the ADD mode.

CHOP — selects channels A and B chopped. In this position the chopper generator (part of IC1601) is switched into the circuit by an earth applied to pins 9 and 10. The input initiates oscillations due to the feedback loop between pins 3 and 2, and 6 and 2 of IC1601. The frequency of oscillation is 2 MHz. This output is fed via an AND/NOR gate of IC1602 to trigger input 1 of flip-flop IC1603. The flip-flop divides the incoming frequency by 2 and switches at a frequency of 1 MHz. The resulting high switching levels on outputs 3 and 6 of IC1604 providing the chopping signals for the A and B channels.

During switchover in the CHOP mode, the c.r.t. is blanked by pulses supplied by transistors TS1601, TS1602 and TS1603. Normally, TS1601 and TS1602 are made fully conducting by the +5 V base supplies via R1604 and R1607. However, in the CHOP mode the negative-going edges of the 2 MHz chopper signal are differentiated by C1602 and produce positive-going pulses at the collector of TS1602. These blanking pulses are fed via TS1603 to the Z amplifier.

ALT — selects channel A and channel B alternately for display. This is a dummy pushbutton without contacts that releases all the other pushbuttons of SK1. The hold-off pulse of the main time-base generator is fed via R817 to the base of TS1613. During the sweep, this pulse is low but during hold-off it is high. Consequently, the hold-off pulses are applied via the collector of TS1613 to input 9 of AND gate IC1602. The output is coupled via the IC1602 gates to the trigger input 1 of flip-flop IC1603. Consequently, it is triggered by a signal which is a replica of the main time-base hold-off pulses. Outputs 3 and 6 of NAND gate IC1604, are, in turn, high and low and the input signals applied to the oscilloscope are alternately displayed by channels A and B.

MULT — selects A channel and diverts A and B signals through multiplier channels. Input 2 of the flip-flop IC1603 is low, consequently output 15 is high and the B output channel is blocked. Output 14 of the flip-flop is low, output 6 of the NAND gate IC1604 is high, consequently the A channel is enabled in the CHANNEL SELECTOR. The high output on point A is also routed via R1612 to block GR1602. As point 1 at conn. T is also high in the MULT mode, GR1601 is also blocked. As described earlier, TS1608 is cut off, TS1607 conducts and −15 V is routed via GR1603 and GR1604 to divert the B signal to the multiplier via internal diode switches. Similarly, the high logic level on T1 cuts off TS1605 and TS1606 to enable the diodes in AMPLIFIER II of the A channel in the multiplier input path. An earth applied to point T3 in the MULT mode blocks diodes GR304 and GR306 to provide blocking potentials (via points 2 and 24) for the through-circuit diodes in AMPLIFIER II of the channel A.

MULT+B — selects multiplier function and B channel. Emitter of TS1612 is earthed and a high logic level on the base in the 0.5 s to 2 ms positions of the MTB TIME/DIV switch SK14 applies a low input to pins 9 and 10 of NAND gate IC1601. Consequently, in these slower positions of SK14 the CHOP mode is selected and points A and B are successively switched at 1 MHz between low and high to select AxB or B channel. In the faster positions of SK14 (1 ms to 0.2 μs) pin 4 of IC1602 is high and consequently the ALTERNATE mode is selected. The A and B points are switched between low and high at the end of each trace to select AxB and B traces alternately.

In both the CHOP and ALTERNATE positions, during the instant when A is low (B channel selected), GR1602 conducts, consequently TS1608 conducts and switches off TS1607 to block diodes GR1603 and GR1604. This enables the B channel whilst the A channel (AxB) is momentarily blocked.

For convenience, the foregoing logic functions are summarised in the following truth table:

SK1 Mode	FLIP-FLOP IC1603 inputs 2	3	outputs 15	14	NAND GATE IC1604 outputs 3(B)	6(A)	Multiply switch logic T1	CHANNEL SELECTOR
A	O		I			I	O	A enabled
B		O		I	I		O	B enabled
ADD					I	I	O	A+B enabled
MULT	O		I			I	I	AxB enabled
MULT+B			O/I	O/I	O/I	I/O	I	AxB/B enabled

The logic circuits controlled by the horizontal mode switch SK2 are now described.

MTB — selects main time-base. This is a dummy pushbutton without contacts, that releases all other pushbuttons of SK2. An earth on input 8 of the alternate flip-flop IC1603 makes output 10 high. This logic level is fed via R1642 to R1472 on the horizontal deflection selector circuit to select the main time-base.

DTB — selects delayed time-base. An earth on input 7 of the alternate flip-flop IC1603 makes output 11 high. This logic level is fed via R1643 to R1497 on the horizontal deflection selector circuit to select the delayed time-base. An earth is also routed to inhibit the +6 V signal applied to the base of TS1614 that automatically selects MTB in the OFF position of the delayed time-base TIME/DIV switch.

ALT TB — selects main and delayed time-bases alternately. Removes an earth from forcing inputs of alternate flip-flop IC1603 and applies it to input 10 of AND gate IC1602 to prevent the A and B channels being directly switched by the alternate pulse. The alternate pulse now switches input 6 of the flip-flop IC1603 to give alternate outputs on 11 and 12 to switch the MTB and DTB in the X deflection selector. The earth is also applied to inputs 12 and 13 of the NAND gate IC1601. The resulting high output is applied to the inputs of three gates. The inputs to 10 and 13 of NAND gates IC1604 allow an adjustable trace separation potential to be alternatively applied to the two paths of the vertical final amplifier depending on whether MTB or DTB is selected by input 6 of alternate flip-flop IC1603. Trace separation is adjustable by front-panel control R9 in series with an internal preset R1657. A variable potential between 0 V and 6 V is applied to the gate of field-effect transistor TS1618, which together with R1652 and R1653 acts as a variable resistance network. The trace separation potential is routed via TS1616 (when MTB switched) or TS1617 (when DTB switched) to the vertical final amplifier. When the ALT TB pushbutton is released, the trace separation potential is bypassed to earth.

The high output 11 on IC1601 is additionally fed to input 13 of AND gate IC1602. Consequently, the output of this gate only changes over the A and B channel select flip-flop when MTB is selected by the alternate flip-flop (i.e. output 11 low).

In the vertical and horizontal ALT modes the switching sequence is therefore as follows, together with the relevant logic levels:

	Selected mode or switching sequence	X alternate flip-flop outputs 10	11	IC1602 AND gate control of Y flip-flop Input 1	Y alternate flip-flop outputs 15	14	Trace IC1604 outputs 8	11	Separation to vertical final amplifier
sequence ↓	MTB and A	I	O	O	I	O	I	O	IC401-16
	DTB and A	O	I	(I)	I	O	O	I	IC401-25
	MTB and B	I	O	O	O	I	I	O	IC401-16
	DTB and B	O	I	(I)	O	I	O	I	IC401-25

EXT.X DEFL — selects external source for horizontal deflection. Inhibits MTB and DTB signals and blanking pulses (see Section 3.2.6).

3.2.1.4. Final Y amplifier

The final Y amplifier comprises three circuit blocks, IC401, IC402 and IC403 and two output transistors, TS401 and TS402. The output signal of the delay line is applied to inputs 18 and 23 of IC401 (DELAY LINE CORRECTION AMPLIFIER).

As the delay line is a source of distortion for higher frequencies, there is a h.f. correction network included between the emitters of both input transistors of IC401. This network consists of capacitors C400 to C407 and C422 and resistors R403 to R408 and R411. Correction of the highest frequencies is possible with the aid of varicap diodes which are incorporated in the DELAY LINE CORRECTION AMPLIFIER block. The bias of the varicap diodes is set by means of preset potentiometers R409 and R410.

Inputs from the TRACE SEPARATION circuit are applied on pins 16 and 25 of IC401.

The DELAY LINE CORRECTION AMPLIFIER block is provided with two symmetrical outputs: 12-15 and 11-14. Output 12-15 is connected to input 26-30 of circuit block IC402 (FINAL AMPLIFIER), and output 11-14 is connected to the input 26-30 of similar circuit block IC403 (FINAL AMPLIFIER).

The outputs of the FINAL AMPLIFIER blocks are connected in parallel and symmetrically applied to output transistors TS401 and TS402.

The overall gain of the final amplifier can be set by means of potentiometer R432 which controls the voltage on point 27 of circuit block IC401 (DELAY LINE CORRECTION AMPLIFIER). When selected, the front-panel BEAM LOCATE switch, SK23, provides an earth to shunt preset GAIN control R432.

The collectors of the output transistors are connected to the Y deflection plates of the c.r.t. Each Y deflection plate consists of four parts which form filters together with coils L401 to L404 and L406 to L409 and the stray capacitances of the deflection plates. The constants of this filter network are chosen in such a way that the propagation velocity of a pulse equals the velocity of the electron beam. In this way, transit-time distortion is kept to a minimum. The filter chain terminates in resistors R418 to R431. The termination is optimized by means of potentiometer R423.

3.2.2. Main Time-base triggering

The trigger unit of the main time-base generator can select any of the following input sources:

— an external source
— the signal of channel A
— the signal of channel B
— a composite signal of channel A and channel B
— a signal derived from the mains supply

All these sources can be used for both triggering and X deflection purposes. Source selection is by means of a five-position pushbutton switch SK21 that feeds the trigger signals to the trigger amplifier.

3.2.2.1. Trigger input circuits and amplifier

A signal on EXT trigger socket BU8 is applied to the gate of input field-effect transistor TS601A, via voltage divider R601-R603 and capacitor C610. When selected, the x3 ATTENUATOR, SK24 connects a further resistor, R630, into the voltage divider chain. The gate of the field-effect transistor is protected against overload by means of two sets of two diodes in series, GR600 and GR601, which limit the gate voltage to + and −1.4 V. Switch SK19 enables selection between a.c. and d.c. coupling of the input signal. If SK19A is depressed, resistors R606 and R607 bypass capacitor C610 with the result that d.c. voltages are applied to the gate of field-effect transistor TS601A. Capacitor C607 suppresses possible interference signals that might be picked up by the long lead between switch SK19A on the front panel, and the trigger unit.

The output signals of field-effect transistors TS601 are applied to the base of transistor TS608. This transistor is, together with transistor TS604, switched in by current source TS607. The latter is controlled by EXT TRIG switch. If this switch is depressed, current source TS607 causes a current to flow through transistors TS604 and TS608, which can then transmit the signals to the trigger amplifier.

The trigger signals from channels A and B are symmetrically applied to similar circuits. For channel A the circuit comprises transistors TS611 and TS613 as gates, and transistor TS612 as a current source. The current source is switched in by means of TRIG A switch.

For channel B the gates are transistors TS614 and TS617, the current source being TS616. The current source is switched in by means of TRIG B switch. Both input A and B are provided with a preset potentiometer to adjust the balance of the stage: R636 for channel A and R656 for channel B.

Signals from the Composite Trigger Amplifier are symmetrically applied to transistor gates TS619 and TS622. Transistor TS621 provides the constant-current source for this circuit. The current source is switched in by the selection of both TRIG A and TRIG B switches.

The other possible trigger source is the MAINS. The trigger signal is transmitted to the trigger unit via a photo coupler in the power supply and applied "common mode" via C616 to transistors TS623 and TS626. This "common mode" drive suppresses fast interference signals and high frequencies in the trigger signal. Transistors TS623 and TS626 are the gates and transistor TS624 is the current source, which can be switched in by means of TRIG MAINS switch.

Depending on which pushbutton of the horizontal deflection controls SK2 is selected, one of the signals described above is used for either triggering or for horizontal deflection. When pushbutton DEL'D TB or MAIN TB is selected, the signal is used for triggering. Alternatively, if pushbutton EXT X DEFL is operated, the signal is fed to the horizontal amplifier on the switching unit. In that case, the signal is picked off from the collector of transistor TS609 which is then switched in, together with transistor TS602, via pushbutton EXT X DEFL.

If pushbutton EXT X DEFL is released, the signal is fed to transistors TS603 and TS618. From these, the signal is applied to that part of the trigger amplifier where the choice is made between h.f., l.f. and d.c. trigger coupling. The choice is made by means of trigger coupling controls SK19.

l.f. trigger coupling

Current source TS728 is switched in. The cathodes of diodes GR603 and GR604 then carry a voltage of approximately +5 V. Consequently, the signal from the trigger pre-amplifier cannot be transmitted via transistors TS627 and TS633. Instead, it is transmitted via the signal path with R681 and R698, amplified by transistors TS629, TS632, TS639, TS637, TS641 and TS636 and applied to the bases of transistors TS642 and TS634. On these points, the trigger signal is integrated and the h.f. components eliminated with the aid of capacitors C622 and C623 which are, at one side, connected to the +5 V voltage mentioned above. Consequently, triggering on the l.f. component of the triggering signal is obtained.

h.f. trigger coupling

Current source TS728 is switched off as pushbutton l.f. is released. Transistors TS629 and TS632 are turned off because their bases are earthed via double diode GR602 and pushbutton h.f. The triggering signal is applied to the bases of transistors TS642 and TS634, via transistors TS627 and TS633 and capacitors C622 and C623. Capacitors C622 and C623 now act as differentiators. Consequently, the l.f. components are blocked and triggering on the h.f. component of the triggering signal is obtained.

d.c. trigger coupling

This is a dummy switch which releases pushbuttons LF and HF. In the DC position, SK19B and SK19C are open and, therefore, both the l.f. and the h.f. paths are in operation. Consequently, the entire triggering signal is transmitted. By means of potentiometer R712 in the emitter circuit of TS641 and TS636, the sensitivity of the l.f. path is equalized to that of the h.f. path. Therefore, the d.c. trigger signal will be undistorted.

The trigger level is set by means of LEVEL potentiometer in the base circuit of transistor TS637. The control range of this potentiometer is preset with the aid of potentiometer R709 in the base circuit of transistor TS639.

Via transistors TS642 and TS634, the signal is applied to the push-pull amplifier with transistors TS643-646 and TS644-647. The amplified triggering signal is applied to the trigger pulse shaper.

3.2.2.2. Trigger pulse shaper

The trigger pulse shaper is incorporated in circuit block IC601 (TRIGGER PULSE SHAPER). The input of this circuit block consists of four transistors, two of which are operating as a Schmitt-trigger at any one time. The position of the +/− trigger SLOPE switch, that enables triggering on either the positive- or negative-going edge of the triggering signal, decides which two transistors are operating.

The next circuit in the TRIGGER PULSE SHAPER block is the trigger multivibrator, which is switched over by the triggering signal. The resulting square-wave signal is differentiated and sharp trigger spikes are obtained. The negative-going spikes are available on output 16 of IC601 and from there are applied to the sweep-gating multivibrator of the main time-base generator. The positive-going pulses are available on output 14 and are used to control the automatic triggering circuit. Potentiometer R737, which is connected to input 23 of IC601, is used to set the overall trigger sensitivity.

3.2.2.3. Auto-circuit

Basically, the auto-circuit comprises electrolytic capacitor C643 across the complementary transistors TS648 and TS749. Positive-going trigger pulses at the base of TS749 cause it to start conducting. Likewise, TS648 starts to conduct and capacitor C643 discharges. The output voltage of the auto-circuit is then approximately −15 V. This voltage is applied to the diode GR803, in the main time-base sweep generator, to make it non-conductive. The sweep-gating multivibrator levels are therefore such that it is driven by the negative-going pulses received via TS801.

When no trigger pulses are available, TS648 and TS749 are non-conducting and C643 charges. Hence, GR803 conducts and the sweep-gating multivibrator levels are set so that initiation of the sweep is dependent only on the sweep feedback voltage. The main time-base sweep generator is therefore free-running.

3.2.3. Main Time-base Generator

The main time-base generator comprises the sweep-gating multivibrator, TS801, TS802, feeding switching transistors TS807 and TS808, the latter being effectively in parallel with the time-base capacitors of the integrator circuit. Transistor TS806 is used as a current source to charge these capacitors. Selection of the appropriate timing capacitors is by means of the TIME/DIV switch SK14 via switching transistors TS815, TS819 and TS821. The sawtooth voltage is developed across the selected time-base capacitor(s) by charging it to a certain level from the constant-current source. The capacitor is then short-circuited very rapidly which results in the characteristic sawtooth waveform.

The sawtooth voltage is fed to TS826 and the left-hand transistor of TS827 in Darlington pair configuration. This stage feeds the sawtooth voltage to the X deflection selector stage and also back to the input of the sweep-gating multivibrator via the hold-off circuit.

The main time-base generator circuit also includes a stage which serves to indicate whether the main time-base generator is triggered or not (GR2). The various stages of the main time-base generator circuit are now considered in some detail.

3.2.3.1. Sweep-gating multivibrator

Sweep-gating multivibrator TS801 and TS802 is controlled by the following signals:

– the negative-going trigger spikes supplied by the main trigger multivibrator via the differentiating circuit,
– the voltage supplied by the hold-off multivibrator,
– the bias voltage supplied by the auto-circuit.

Potentiometer R806 provides a preset control of trigger stability. Transistor TS805 is a current source to make the sweep-gating multivibrator insensitive for possible fluctuations in the supply voltage. The output square-wave of the sweep-gating multivibrator is applied to the switching transistors TS807 and TS808.

3.2.3.2. Switching transistors TS807 and TS808

Transistor TS808 is the switching transistor that is effectively in parallel with the selected time-base capacitance. Whenever this transistor receives a positive-going pulse from the sweep-gating multivibrator, it starts conducting and the time-base capacitance is discharged. Transistor TS806 provides the constant-current source to charge the capacitance. Transistor TS807, the other switching transistor, short-circuits the charging current to earth when the time-base capacitors are being discharged. Both switching transistors are driven with the same control signal, supplied by the sweep-gating multivibrator.

3.2.3.3. Sweep speeds

The sweep speed or time coefficient is determined by the value of the time-base capacitance in circuit, and by the magnitude of the charging current selected.

The time-base capacitors are C805, C806, C807 and C808. Capacitor C806 is always in circuit; the other three capacitors are selected by transistors TS815, TS819 and TS821. These operate as electronic switches and are either fully cut-off or fully-conducting. They are switched on by the application of a positive voltage to their bases from the TIME/DIV switch (SK14). According to the position of SK14, these transistors switch in the relevant capacitor in parallel with C806. As mentioned, the sweep speed is also dependent on the magnitude of the constant-current charge supplied by transistor TS806. This current can be adjusted in steps by selecting the emitter resistance of TS806 by means of the TIME/DIV switch SK14. Continuous control of the charging current can be effected by varying the base drive to TS806 with the vernier sweep control, TIME/DIV potentiometer R14. In the CAL position of this potentiometer, switch SK15 closes and the charging current is solely determined by the calibrated emitter resistance. A correction circuit on the Horizontal Deflection Selector circuit increases the charging current for the highest sweep time in the x10 position (2 ns/DIV).

To compensate for the temperature coefficient of the transistor (2 mV/deg C) the base voltage of TS806 is supplied via transistor TS809. This also has the advantage of reducing the load on the TIME/DIV potentiometer. Electrolytic capacitor C800 suppresses any possible ripple and interference present on the supply voltage rail.

Time-base capacitors C805, C806 and C808 are precision capacitors. Capacitor C807 (4.7 μF), however, has a ±10 % tolerance. This is compensated for by potentiometer R834 in the collector circuit of transistor TS811. With the aid of this potentiometer, the base voltage of TS809 is additionally controlled in those positions of the TIME/DIV switch SK14, where capacitor C807 is switched in. In positions of SK14 where C807 is not switched in, diode GR802 is blocked and the additional control is inoperative.

3.2.3.4. Sawtooth take-off circuit

The sawtooth waveform generated by the time-base is applied to the darlington pair, comprising TS826 and the left-hand transistor of TS827, the emitter output of the latter being coupled to the X deflection selector, the comparator circuit and to the hold-off circuit of the main time-base via diode GR808.

3.2.3.5. Hold-off circuit

The hold-off circuit prevents the sweep-gating multivibrator from responding to trigger pulses before the time-base capacitor has fully discharged. The sawtooth output from the Darlington pair is applied via diode GR808 to the base of emitter follower TS824. Switching transistors TS820, TS822 and TS823 select the appropriate hold-off capacitor, C809, C810 or C811, according to the position of SK14, in a similar manner as described for the main time-base integrator timing capacitors. Capacitor C812 is always in circuit irrespective of the TIME/DIV switch position.

The selected hold-off capacitor is charged via transistor TS824 and discharged via TS825. Discharging in this case takes a considerably longer time than the discharging of the time-base capacitors. The bias of transistor TS825 can be varied by means of front-panel potentiometer X DEFL/HOLD-OFF (R22), in order to manually vary the hold-off time.

The voltage across the selected hold-off capacitor drives the Schmitt trigger TS816, TS817, the hold-off multivibrator. The output signal of the hold-off multivibrator is applied to the input of the sweep-gating multivibrator via emitter follower TS814. This emitter follower, TS814, buffers the hold-off multivibrator from the triggering spikes of the trigger pulse-shaping circuits.

Switch SK9, located in the base circuit of transistor TS824 is closed when pushbuttons AUTO and TRIG of the trigger-mode controls are operated. If these buttons are released (pushbutton SINGLE operated), switch SK9 is open. Then diode GR808 stops conducting and the hold-off multivibrator TS816, TS817 is no longer reset by the sweep voltage. The hold-off multivibrator is now reset via transistor TS818, by pressing SINGLE pushbutton SK9C.

When the oscilloscope is used with an external X deflection signal, the internal time-base generator is switched off by depressing the EXT X DEFL pushbutton of SK2 in the base circuit of transistor TS818. This transistor holds the hold-off multivibrator so that its output prevents the sweep-gating multivibrator from responding to trigger pulses.

3.2.3.6. "NOT TRIG'D" indicator

Light emitting diode GR2 in the collector circuit of transistor TS812 serves two purposes:

- it provides a front-panel indication when the time-base generator is not triggered in the AUTO and TRIG modes; i.e., it indicates the absence of trigger pulses. In this condition, electrolytic capacitor C643 of the auto-circuit in the main trigger circuit is charged. Consequently, the emitter of TS813 becomes less negative and the transistor cuts off. The earth applied via R838 switches on TS812 and the NOT TRIG'D diode, GR2, lights. On receipt of trigger pulses, C643 is discharged, TS813 conducts and cuts off TS812, thus extinguishing GR2.
- in the SINGLE mode, the NOT TRIG'D lamp also serves as a reset indicator, On selection of the SINGLE pushbutton, the lamp remains on until the sweep is initiated by a trigger pulse. In this mode, the trigger pulse drives the base of TS813 dependent on the state of the hold-off multivibrator TS816, TS817.

Note: The instrument also operates in the SINGLE mode if none of the trigger-mode controls is depressed.

3.2.3.7. Switching transistors TS803 and TS804

Transistors TS803 and TS804 are part of the output circuit of the sweep-gating multivibrator. Transistor TS803 supplies pulses for the ALT supply of channels A and B to the channel selector logic, and reset pulses for the delayed time-base generator. Transistor TS804 provides blanking pulses that are applied to the Z amplifier, via the switching unit, in order to suppress the beam when the time-base generator is in the hold-off position.

3.2.3.8. Delay-time function

The function of the DELAY TIME potentiometer R1 is to provide an adjustable d.c. voltage for comparison with the sweep voltage of the main time-base generator. This comparison voltage is then used to start the delayed time-base generator at a pre-determined time during the sweep of the main time-base. The comparator circuit is described in the delayed time-base generator section (3.2.5.3.). The DELAY TIME potentiometer is a 10-turn front-panel control.

3.2.4. Delayed Time-base Triggering

The trigger unit of the delayed time-base is almost identical to that of the main time-base trigger unit, the circuits of which are described in section 3.2.2. Unlike the main time-base trigger unit, the delayed time-base trigger unit has no provision for external X deflection, triggering from the mains frequency, or for composite triggering.

3.2.5. Delayed Time-base Generator

As the delayed time-base generator is basically similar to the main time-base generator (section 3.2.3), only the essential differences are described.

3.2.5.1. Sweep speeds

The circuit is similar to that of the main time-base generator, but the constant-current source for the time-base capacitors is provided with an extra preset potentiometer R1227. This potentiometer enables the sweep speeds of the delayed time-base generator to be equalized to those of the main time-base generator.

3.2.5.2. Hold-off circuit

The sawtooth voltage is applied, via diode GR1204 and emitter-follower TS1224, to the hold-off multivibrator TS1218, TS1219. The output voltage of the hold-off multivibrator brings the sweep-gating multivibrator in the hold-off position via emitter-follower TS1217. The sweep-gating multivibrator is reset with the aid of reset multivibrator TS1222, TS1223. The base of TS1223 is driven by the output signal of the sweep-gating multivibrator in the main time-base generator and by the output signal of the comparator. The reset multivibrator is switched over by the combination of these signals. As a result of this, the hold-off multivibrator is reset via emitter follower TS1221 and, thus, the sweep-gating multivibrator TS1201, TS1202. If pushbutton STARTS (SK8A) has been operated, the next sweep is then initiated. If, however, the TRIG pushbutton has been selected, the sweep-gating multivibrator is switched over by a trigger pulse on the base of transistor TS1201. In the OFF position of TIME/DIV switch SK12, the sweep-gating multivibrator is kept in such a state that is responds to neither trigger pulses nor reset pulses of the hold-off multivibrator.

3.2.5.3. Comparator

The comparator comprises the transistors TS1226 and TS1227. Transistor TS1226 is a double transistor in long-tailed pair circuit, TS1227 being a current source for this circuit. The d.c. voltage set by DELAY TIME potentiometer R1 is fed to the base of the right-hand transistor of TS1226, via R1282. The sawtooth voltage of the main time-base generator is fed to the left-hand transistor of TS1226, via R1281. As soon as the amplitude of the sawtooth exceeds the set d.c. voltage, the collector voltage of the left-hand transistor of TS1226 drops. This voltage drop is, together with the output signal of the sweep-gating multivibrator of the time-base generator, fed to the reset multivibrator TS1222, TS1223 as described in the previous section. A delayed pulse output is available on socket BU11 at the rear of the instrument.

3.2.6. Horizontal Deflection Selector

The horizontal deflection selector board U8 comprises the following circuits:

- a selector for the X deflection source
- a switching circuit for the c.r.t. blanking pulses
- an X preamplifier for external X deflection signals
- an X intermediate amplifier.

3.2.6.1. X deflection source selector

Depending on the selected position of SK2, the circuit provides for X deflection by the main time-base signal, the delayed time-base signal, alternate deflection by both time-base signals or deflection by the signal from an external source. The logic circuits have already been described in section 3.2.1.3.

With MAIN TB pushbutton selected, transistor TS1427 emitter receives a high logic signal from the alternate flip-flop (via R1642) and it starts to conduct. Transistor TS1407 also conducts and, via R1423, switching diodes GR1401 and GR1402 are unblocked. Consequently, the output signal from the main time-base is fed to the intermediate X amplifier. The conductance of TS1407 also results in TS1408 and TS1409 being turned off. Diodes GR1403, GR1404 and GR1406, GR1407 are therefore blocked and signals from the delayed time-base or external X deflection signals are blocked. Transistor TS1404 also conducts when MAIN TB is selected and TS1406 turns off. Resistor R1422, the load of the main time-base generator, is then out of circuit and is replaced by R1423. Thus, a constant load is maintained for all positions of the X deflection controls. The MTB SWEEP OUT facility on rear-panel socket BU12 is fed from emitter-follower TS1410. This external output is derived before the switching diodes. It is therefore available irrespective of whether the main time-base is displayed.

With the DEL'D TB pushbutton selected, transistor TS1428 receives a high logic signal on its emitter from the alternate flip-flop (via R1643) and starts to conduct. Transistor TS1408 also conducts and, via R1424, switching diodes GR1403 and GR1404 are unblocked and the delayed time-base signal is fed to the intermediate X amplifier.
Similarly, when EXT X DEFL is selected, TS1409 conducts by an earth applied to its base via R1434. Switching diodes GR1406 and GR1407 are unblocked to permit external X deflection signals to pass to the intermediate X amplifier.

3.2.6.2. Blanking pulse switching circuit

The switching circuit for blanking pulses from the main time-base comprises transistors TS1419, TS1421, TS1422 and TS1429. The switching circuit from the delayed time-base comprises transistors TS1423, TS1424, TS1426 and TS1431. The collectors of output transistors TS1422 and TS1424 are commoned to provide an input for the Z amplifier via R507. The current injected into the Z amplifier by these transistors is 0 mA for trace unblanking and 3 mA for complete trace blanking.
The emitters of TS1419 and TS1423 are connected, via load resistors R1474 and R1489, to resistors R819 and R1219 in the main and delayed time-bases respectively. During the sweep, 3 mA flows into the main time-base generator: 0 mA flows during the hold-off period. In the OFF position of the delayed time-base TIME/DIV switch 3 mA flows into the delayed time-base generator. These currents are supplied via resistors R1473 and R1491. The collector currents of TS1419 and TS1423 are 5 mA during the hold-off period and 2 mA during the sweep. Of these collector currents, 2 mA flows to the −15 V supply via resistors R1479 and R1492. This results in a current for trace unblanking of 2 − 2 = 0 mA and current for trace blanking of 5 − 2 = 3 mA.

Assume that the MAIN TB is selected; i.e. alternate flip-flop signal via R1642 is high. Transistor TS1429 conducts and TS1421 is turned off. The current step from 0 to 3 mA is applied to the Z amplifier via TS1421. Conversely, if MAIN TB is not selected transistors TS1421 conducts and the full current step from 0 to 3 mA is short-circuited via this transistor. The input current of the Z amplifier is then 0 mA and it gives bright-up information.

Assume that only the DEL'D TB is selected; i.e. alternate flip-flop signal via R1643 is high. Transistor TS1431 conducts and TS1426 is turned off. The 0 to 3 mA blanking information is fed to the Z amplifier via transistor TS1424.

If EXT X DEFL is selected, an earth applied from SK2(C) to the bases of TS1422 and TS1424 blocks these transistors and no blanking information is fed to the Z amplifier and the trace is unblanked.

The other possibility is the main time-base intensified by the delayed time-base. During the portion of the sweep where only the main time-base is running, i.e. before the delayed time-base starts, no current flows to the Z amplifier via TS1422 and the trace is unblanked. However, the Z amplifier receives 3 mA from the delayed time-base via TS1424. Thus, the trace is blanked as the nett input current to the Z amplifier is 3 mA. As soon as the delayed time-base starts and the intensified portion begins, the current through TS1424 is zero and the Z amplifier gives bright-up of the trace. At the end of the delayed sweep the current through TS1424 is restored to 3 mA and trace blanking occurs. In the foregoing explanation only the intensified portion of the trace is visible. However, it is possible to drain off some of the 3 mA blanking current of TS1424 via the parallel transistor TS1426. The current supplied by TS1423 is drained off by TS1426 depending on the position of the INTENS potentiometer R20. The dark level can be preset by the BRILLIANCE RATIO potentiometer R1498. The INTENS control operates so that the intensity relationship between the normal and intensified part of the trace is constant.

3.2.6.3. X preamplifier for external X deflection signals

The X preamplifier comprises transistors TS1400, TS1401, TS1402 and TS1405. The input signal is applied to the emitter of TS1400 via resistors R1404. The input signal may be one of those used for triggering, i.e. a voltage on EXT input socket BU8, channel A or B signals, a composite trigger signal or a mains-derived signal (section 3.2.2.1.).

If EXT X DEFL is selected, the collector signal of TS1609 in the main trigger circuit is fed to R1404. The signal is amplified by transistors TS1400 and TS1402 and then applied to switching diode GR1406 in the X deflection selector stage. The base bias of transistor TS1400 is adjustable by preset R1401 which is used to balance the amplifier against trace shift when AMPL X INPUT control R22 is rotated. The latter controls the gain of the amplifier via field-effect transistor TS1403 in conjunction with the preset X DEFL GAIN control R1419.

Transistor TS1401 is a constant-current source. Trimmer capacitor C1408 provides a bandwidth adjustment for the amplifier.

3.2.6.4. Intermediate X amplifier

The intermediate X amplifier comprises transistors TS1412 to TS1418. The asymmetrical output signal of the X deflection selector (anodes of GR1402, GR1404 and GR1407) is applied to the base of transistors TS1412 and TS1413. An anti-phase signal is generated by means of transistors TS1417 and TS1417, resulting in a symmetrical signal being fed to the X output amplifier. The base bias of transistors TS1417 and TS1418 can be varied by X POSITION potentiometer R2. Variation of the bias causes unbalance of the push-pull amplifier, which results in a horizontal trace shift on the screen.

The amplifier offers the possibility of using either the nominal gain (x1 position of TB MAGN switch SK3), or the gain increased by a factor of 10 (x10 position of the TB MAGN switch).

In the x1 position of TB MAGN switch SK3, current source TS1416 in the emitter circuits of transistors TS1413 and TS1418 is switched in and these transistors are then operative. However, transistors TS1412 and TS1417 are inoperative because their current source TS1414 is turned off. The gain of this stage can be set by means of potentiometer R1462.

In the x10 position of TB MAGN switch SK3, TS1414 starts conducting. Consequently, transistor TS1416 turns off. Transistors TS1412 and TS1417 are switched in and the amplifier stage with TS1413 and TS1418 is inoperative. The gain of amplifier stage TS1412 - TS1417 is ten times higher than that of the previously discussed stage, and can be set by means of potentiometer R1444. Light-emitting diode GR1 indicates the 10x TB MGAN condition. The x10 amplifier is also inoperative if either the EXT X DEFL pushbutton (SK2C) or the BEAM LOCATE pushbutton (SK23) is depressed.
The outputs of both amplifier stages are connected to the final X amplifier by means of coaxial cables.

3.2.7. Final X Amplifier

The final X amplifier consists of two amplifier stages in parallel (one for each deflection plate). In the following, one half is described.

The actual amplifier comprises the cascode circuit with transistors TS1702 and TS1703. Resistors R1704 and R1707 are feedback resistors. The cascode amplifier is controlled via transistor TS1704 in common-base configuration. Resistor R1712 is the termination for the coaxial cable between the intermediate X amplifier and the final amplifier. Current source TS1701 supplies the bias current for the amplifier. The average voltage on the deflection plate is kept at +26 V by means of zener diode GR1702. Capacitor C1701 improves the h.f. response and trimmer C1703 allows phase compensation in the feedback path of the cascode circuit.

3.2.8. C.R.T. circuits

3.2.8.1. Z modulator circuit

Basically, the Z unit comprises an amplifier and a modulator/demodulator circuit for the d.c. and low frequency components of the blanking signal. The latter circuit isolates the Z unit from the high potential (−1800 V) present on the c.r.t. cathode and Wehnelt cylinder.

Input signals to the Z amplifier are received from three sources:
– the blanking pulses from the time-base via R507
– the chopper blanking pulses from the channel selection logic via R506
– an external Z input on rear-panel socket BU9 via the complementary transistors TS501, TS502.

As stated in section 3.2.6.2., the blanking current is 3 mA and the unblanking current 0 mA. Transistor TS504, connected in common-base configuration, feeds the current pulses to the amplifier stage, TS508, TS509. Front-panel control R20, the INTENS potentiometer, provides an adjustment of trace brilliance by regulating the base bias of TS503. The slider of R20 is also coupled to the delayed time-base bright-up circuit via R1501 to maintain the desired intensity ratio for all settings of R20. (See also section 3.2.6.2.)

A portion of the input current is drained off via TS503 depending on the setting of R20; the larger the current drain, the more brilliant the trace. Conversely, the more brilliant the trace, the less the common-base transistor TS504 conducts. Since TS504 is cut off, GR504 is also non-conductive and a small current flows through R518 and prevents TS509 and TS508 from bottoming.

The blanking signal is passed by TS504 to the base of TS509 via GR504. The diode GR506 in the collector circuit of TS504 clamps the black level of the blanking current fed to the amplifier at 3 mA.

The output of the amplifier stage TS509, TS508 is coupled to emitter follower TS507, the output of which switches between 4 V and 40 V approximately for blanking and unblanking respectively. At this point, the a.c. and d.c. components of the blanking signal are routed along different paths. The high frequency components of the signal are passed via capacitor C522 to the Wehnelt cylinder of the c.r.t. The d.c. and low frequency components of the signal are passed via the low-pass filter R534, C511 and R532 to the emitter of TS512. Together with TS511, TS512 forms a multivibrator, the frequency of which is approximately 30 kHz. The oscillator output on the collector of TS512 is therefore modulated by the Z amplifier, the peak-to-peak value depending on the d.c. and l.f. components fed to the emitter of TS512. The black level can be adjusted by the preset R547. Capacitor C521 feeds this modulated signal to a peak-to-peak detector and also serves to isolate the high potential present on the c.r.t. cathode circuit. After demodulation by the detector circuit GR511, GR512, C524, R564, the d.c. and l.f. components are, via R567, recombined with the a.c. components and routed to the Wehnelt cylinder of the c.r.t.

3.2.8.2. Focusing circuit

The electron beam is focussed with the aid of FOCUS potentiometer R21 which controls the emitter voltage of transistor TS514. This transistor constitutes, together with transistor TS513, a multivibrator identical to the one with transistors TS511 and TS512. Across the collector resistor of TS514, R555, a signal arises with amplitude dependent on the position of FOCUS potentiometer R21. This signal is rectified in the encapsulated circuit which comprises, to this end, a double peak detector. The rectified voltage, approximately 200 V, is applied to focusing anode g3 of the c.r.t.

The emitter voltage of transistor TS514 does not only depend on the position of the FOCUS potentiometer, but is also determined by the position of the INTENSITY potentiometer R20. The signal from this potentiometer is applied to the emitter of TS514, via transistor TS516. In this way a form of compensation is obtained: the focus of the electron beam is automatically adapted when the brilliance of the trace is varied. The necessity of readjusting the FOCUS control after rotating the INTENS potentiometer is thus largely obviated.

3.2.8.3. H.T. converter

The −1800 V supply for the cathode, Wehnelt cylinder and focus electrode, and the +18 kV supply for the post-acceleration anode g9 are derived from the h.t. converter circuit.

Transistor TS2004 together with transformer T2001 forms an oscillator, operating at a frequency of between 25 kHz and 30 kHz. An a.c. waveform of 1800 V is developed across the secondary winding of the transformer. This voltage is rectified by diode GR2001 and fed to the previously mentioned encapsulated circuit. The voltage on the anode of diode GR2001 is −2170 V. The secondary voltage of transformer T2001 is also rectified and multiplied by a factor of 9 in an encapsulated multiplier circuit, in order to obtain the required +18 kV.

The output voltage of the converter is kept constant by means of a regulator circuit. This circuit comprises transistors TS2001 and TS2003. The 2 kV voltage on the cathode of the c.r.t. is fed back to the base of transistor TS2003, via resistor R573 in the encapsulated circuit. If this voltage drops, the base current of transistor TS2003 increases, as its base voltage is also connected to the +46 V voltage via resistors R2002 and R2003. An increasing base current of transistor TS2003 causes the current through transistor TS2001 to increase. As a result of this, the base current of transistor TS2004 grows and the generated voltage increases. The regulation operates in an analogous way, but in reverse direction, when the 2 kV voltage rises.

The 2 kV voltage is also protected against short-circuits (the 18 kV voltage is protected by its high internal resistance). If the current drain from GR2001 becomes too high, diode GR2003 turns off. Under normal conditions, this diode is always conducting. This means that normally the cathode is approximately 0.7 V negative with respect to earth. In case of overload or short-circuit of the 2 kV voltage, this 0.7 V is cancelled out or may even become positive, depending on the magnitude of the short-circuit current. This causes the base voltage of transistor TS2002 to go positive and this transistor starts conducting. As a result of this, the current through transistor TS2003 decreases, causing a reduction of the current through transistor TS2001. Consequently, the base current of transistor TS2004 decreases and the converter switches off.

3.2.9. Calibration Unit

The calibration unit comprises a built-in square-wave generator using an operational amplifier IC1901 with feedback loops. The frequency-determining components are resistor R1909 and capacitor C1903. Point 3 of the operational amplifier IC1901 is kept equal to the average output voltage by capacitor C1902. In this way, the generator is independent of supply voltages. Zener diode GR1901 determines the amplitude of the square-wave output, and potentiometer R1906 allows accurate adjustment of output voltage and current.

The calibration unit gives an output of 3 $V_{p\text{-}p}$ at 6 mA at a frequency of 2 kHz ±2 %. The output is protected against continuous short-circuits.

3.2.10. Power Supply

The power supply is designed on the switching regulator principle, thus permitting the PM 3265 oscilloscope to be connected to any a.c. mains voltage between 90 V and 264 V, or any d.c. voltage between 125 V and 264 V, without the need for mains voltage adapters. All voltage output rails are stabilised and a current-limiting circuit protects against overloads.

The basic circuit functions of the power supply are as follows:
- mains rectifier and ripple elimination circuit
- switching series regulator
- chopper circuit
- voltage sensing and regulator circuit
- current-limiting circuit
- surge protection circuit
- secondary supply voltage circuits.

General

In principle, the power supply operates as follows. After rectification, the smoothed input voltage is fed to the switching series regulator. A pulse-width modulated switching transistor and commutating diode supply a filter network which averages the voltage. This voltage provides the supply for the chopper that provides the necessary alternating waveform for the supply transformer. In addition, part of the chopper squarewave output is rectified, compared with a reference voltage and is fed back to control the on-off ratio of the switching transistor. The power supply circuits are located on printed circuit board U5.

3.2.10.1. Mains rectifier

The mains voltage or an alternative source of supply is applied to the mains filter unit via the ON/OFF switch SK22 and the slow-blow fuse VL1. The mains filter consists of two double-wound chokes L1801 and L1802, together with capacitors C1801, C1802 and C1803, followed by a second filter consisting of two HF chokes. These filters suppress mains-borne interference to the instrument and also interference from the instrument; e.g., switching transients, to the mains supply. The mains rectifier GR 1801 ... GR 1804 comprises four diodes in a bridge circuit. The buffer capacitors C1806 and C1807 are charged to approximately the peak voltage of the mains supply.

3.2.10.2. Switching series regulator

Transistor TS1801 is the switching transistor, the base of which is driven by the pulse-width modulated rectangular waveform. The filter network comprises the choke L1804 and the capacitor C1809.
A current flows through L1804 during the turn-on time of TS1801. During the turn-off time, the back e.m.f. of L1804 provides a current via the commutating diode GR1811. This action is repeated at a frequency of approximately 20 kHz, the chopper frequency. An output voltage is thus developed across C1809 dependent upon the on/off ratio of the switching transistor TS1801. To initiate starting, a small base current is fed to transistor TS1801 via resistors R1804, R1803, R1817, the auxiliary winding of L1804, and R1825.
starting, a small base current is fed to transistor TS1801 via resistors R1804, R1803, R1825, the auxiliary winding of L1804, and R1825

To limit power dissipation in TS1801 during switching, positive feedback applied to the base circuit from the auxiliary winding of L1804 assists the transistor to reach saturation or to discharge the base. The choke, in series with TS1801 and L1804, also reduces the initial peak energy in TS1801, since for the leading edge it is effectively the only collector load.

3.2.10.3. Chopper circuit

The chopper circuit is formed by transistors TS1803 which, together with the base drive transformer T1801, form a push-pull oscillator. The primary windings 3-4-5 of the converter transformer T1802 provide the collector loads for the chopper transistors. Winding 7-8 supplies the driver transformer T1801 and also the necessary supply for IC1801. As the driver transformer T1801 saturates easily, a squarewave signal is generated.

The chopper is started by the voltage developed across zener diode GR1813. When the zener voltage (75 V) is attained a starting base current is supplied to the chopper transistors via R1813 and the centre-tap of the driver transformer, TS1801. As the chopper starts, the voltage across C1809 falls but rises again due to the current supplied by TS1801 controlled by the regulator circuit. If, for any reason, the chopper fails to start, thyristor TS1802 is fired by the excess voltage developed across C1830. The thyristor thus provides a fusing function by discharging the output voltage build-up across capacitor C1809.

During oscillation, a voltage is developed on the centre-tap of the driver transformer T1801 of approximately 1 V negative with respect to the emitter of TS1803. With this negative potential on the base circuit faster discharging of the hole-storage capacitance for the chopper transistors is realised. Between base and collector of both transistors TS1803, diodes are connected to prevent excessive saturation.

3.2.10.4. Voltage sensing and regulator circuit

Regulation of the chopper output is achieved by comparing a portion of its output voltage against a stable reference and feeding the error voltage back via an operational amplifier to control the on/off ratio of the switching transistor. The basic components of the sensing and regulating circuit are primary winding 7-8 of T1802, integrated circuit IC1801, potentiometer R1828 and transistor TS1806.

The circuit operates as follows. The squarewave voltage of approximately 20 V_{p-p} across winding 7-8 of T1802 is half-wave rectified by GR1824 and produces a d.c. voltage of approximately −8 V with a superimposed ripple of about 350 mV^{p-p} across C1817. An internal voltage reference (7 V with respect to the −8 V) between points 4 and 5 of IC1801 result in an input voltage at point 2, via R1826, of approximately −1 V. The ripple voltage superimposed on this d.c. reference via C1814 is used to control the switching level by comparison with the error voltage at the non-inverting input.

This input 3 of IC1801 is connected to the wiper of R1828, the potentiometer that measures the error voltage across C1817 via R1827, R1829 and diode GR1823 to the "O". The remaining ripple of this point is filtered by capacitor C1816. Diode GR1823 conducts via R1831 because of the positive potential across C1818 of approx. +8 V.

Although the ripple at the inverting input 2 approximates to a sawtooth waveform, because of the high gain of the amplifier, the output on point 6 is a rectangular waveform. The on/off ratio of this rectangular waveform is dependent upon the internal reference voltage with superimposed ripple compared with the error voltage on wiper R1828. This rectangular waveform on point 6 is applied to the base of TS1806 which, in turn, controls the on/off time of the switching transistor TS1801.

The overall function of the voltage sensing and regulator circuit is best considered by assuming a change in output. Any tendency for the output to increase would produce an increase in voltage across C1817. The voltage on input 2 of IC1801 will go more negative as a result. Likewise, the voltage on input 3 will go more negative, but to a lesser extent because of the dividing action of the potentiometer R1828 and its associated circuit. Because of this differential, input 2 will be more negative with respect to input 3. In terms of the output on point 6, this means that the positive-going rectangular waveform will be of longer duration over the duty cycle. This signal is inverted by transistor TS1806, which results in transistor TS1801 being blocked for a longer period. Consequently, the output of the switching series regulator decreases and restores circuit equilibrium.

In addition to output sensing, forward control is provided from the mains voltage. Input 3 of IC1801 is also coupled to the rectified mains voltage via resistor R1806. Any variation in mains voltage will be reflected at the input 3 of IC1801. The resulting differential with respect to input 2 will produce a compensating regulating action as described.

3.2.10.5. Current-limiting circuit

A current sensor circuit automatically cuts off the series regulator if excessive current is demanded by the circuit. The current-limiting circuit comprises transistor TS1811, thyristor TS1808 and their associated components.

The current supplied by the power unit flows through the series resistor R1802 and the potential drop across this resistor is used to control transistor TS1811. If the supply current becomes excessive, transistor TS1811 starts to conduct. In turn, TS1808 fires and the voltage on the base of TS1807 decreases. This transistor is then cut off, TS1806 conducts and turns off switching transistor TS1801. Consequently, the chopper stops operating. However, the small base current fed to TS1801 via resistors R1804, R1803 and R1817 enables C1809 to charge. When the zener potential of GR1813 is reached, the chopper restarts and is switched off again immediately if the overload or short-circuit persists. Depending on the mains voltage, this cycle is repeated so long as the fault condition persists.

3.2.10.6. Surge protection

In similar manner to the current-limiting circuit, a surge protection circuit cuts off the switching series regulator if, for any reason, the output voltage of the power supply is too low for the amplifier IC1801 to give satisfactory control. Voltage sensing is performed by transistor TS1807. During initial switch-on of the instrument, if the voltage across winding 7-8 is too low, TS1807 is cut off because of the voltage threshold of 5,1 V on its base.

Consequently, the positive potential developed across C1808 is applied via R1832 to the base of TS1806. This transistor conducts and turns off switching transistor TS1801. The circuit prevents damage to the switching transistor, which could occur if it were operated with insufficient base current.

When its threshold voltage is reached, TS1807 conducts and passes the base current of TS1806. Transistor TS1806 is blocked and allows TS1801 to conduct via R1818. The RC time-constant of R1832 and C1808 is shorter than that of the +8 V supply to the integrated circuit at switching on and, due to lower power consumption, is stable for a longer period at switching off.

3.2.10.7. Secondary supply voltages

The primary windings of the supply transformer T1802, as previously stated, are the collector load circuits of the chopper transistors. The secondary windings providing the voltages for the various circuits in the instrument are completely isolated from the mains power supply.

The filament of the c.r.t. is supplied by the voltage across secondary winding 17-18, rectified by GR1831 and smoothed by electrolytic capacitor C1824. One side of the winding is a.c.-coupled to earth via C1825.

All other supply feeds are derived from tapping points on a single secondary winding, earthed at a single point (10) to the transformer screen to reduce interference. Each supply is individually rectified and smoothed.

3.2.10.8. Mains triggering opto-isolator

The trigger source or X display derived from the mains supply is completely isolated from dangerous mains voltages by an opto-isolator TS1809. This consists of a light-emitting diode and photo-transistor in one envelope.

The a.c. mains derived from the mains filter is rectified by diode GR1828 and fed through the light-emitting diode TS1809. The output signal is filtered and routed to the trigger amplifier via capacitor C1822.

3.3. DISMANTLING THE INSTRUMENT

3.3.1. General information

Warning: The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts, and also accessible terminals may be live.

The instrument shall be disconnected from all voltage sources before any adjustment, replacement or maintenance and repair during which the instrument will be opened.
If afterwards any adjustment, maintenance or repair of the opened instrument under voltage is inevitable, it shall be carried out only by a skilled person who is aware of the hazard involved.
Bear in mind that capacitors inside the instrument may still be charged even if the instrument has been separated from all voltage sources.

This section provides the dismantling procedures required for the removal of components during repair operations. All circuit boards removed from the oscilloscope should be adequately protected against damage, and all normal precautions regarding the use of tools must be observed. During dismantling procedures, a careful note must be made of all disconnected leads so that they may be reconnected to their correct terminals during assembly.

The E.H.T. cable is unbreakably connected to the c.r.t.
When the E.H.T. cable to the post-acceleration anode of the c.r.t. is disconnected at the E.H.T. unit end, the E.H.T. cable must be discharged immediately by shortening them to earth.

Damage may result if the instrument is switched on when a circuit board has been removed, or if a circuit board is removed within one minute after switching off the instrument.

3.3.2. Removing the cabinet plates and the screen bezel

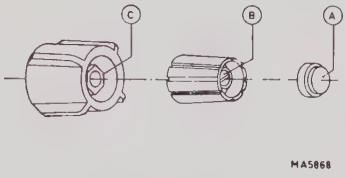
Both upper and lower cabinet plate can be removed after slackening one or two turns the four quick-release fasteners at the corners of each plate. Do not slacken the fasteners more than two turns, otherwise they may come apart.

The screen bezel can be detached by pressing the longer edges and pulling out.

3.3.3. Removing the knobs

3.3.3.1. Single knobs

– Prise off cap A
– Slacken screw (or nut) B
– Pull the knob from the spindle



3.3.3.2. Double knobs

– Prise off cap A and slacken screw B
– Pull the inner knob from the spindle
– Slacken nut C and pull the outer knob from the spindle

When fitting a knob or cap, ensure that the spindle is in a position which allows reference lines to be coincident with the markings on the text plate of the oscilloscope.

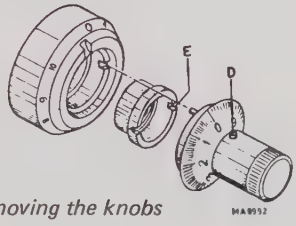


Fig. 3.9. Removing the knobs

3.3.3.3. Delay-time multiplier knob

– Slacken screw D using a hexagonal key and pull the knob from the spindle
– Remove the nut E and withdraw the ring from the spindle

When fitting the vernier control, turn the spindle of the potentiometer fully anticlockwise. Place the ring on the spindle so that the reference line corresponds to the zero mark on the calibrated scale. Then lock it with nut E. Fit the inner knob so that its cam is engaged with the slot in the ring. Rotate the inner knob until its zero mark coincides with the reference line on the ring. Secure the assembly by tightening screw D.

3.3.11. Removing the cathode-ray tube

ATTENTION: Be very careful with the side connections of the c.r.t. If these pins are bent, the c.r.t. is likely to develop a gas leak.

- Slacken the brace round the c.r.t. neck and remove the connections between c.r.t and Y output amplifier
- Remove the tube base
- Unplug the multipole connector of the orthogonality and trace-rotation coils on the intermediate amplifier
- Remove the metal housing of the E.H.T. unit and disconnect the E.H.T. cable (discharge the cable)
- Slacken the upper plastic centring bracket at the c.r.t. front
- Slacken the two screws that secure the mu-metal screening pipe to the rear chassis.
- Remove the bezel
- Carefully withdraw the c.r.t. through the front panel of the instrument
- If the rubber sleeve around the neck of the c.r.t. must be slid over the neck of a replacement tube, the use of industrial talcum powder is strongly recommended.

3.3.12. Removing the push-button sets

Each of the push-button sets mentioned below is fitted to the front panel by means of two clamping devices:

The A/ALT/CHOP/ADD/MULT/B set
The DEL'D TB/ALT TB/EXT X DEFL/MAIN TB set
The NORM/INVERT & NORM/INVERT set
The STARTS/TRIG & AUTO/TRIG/SINGLE set
The DC/LF/HF & DC/LF/HF & A/B/EXT & A/B/EXT/MAINS set

To remove a push-button set, the two recessed-head screws that secure the set to the front panel must be removed.
To replace one switch of a push-button set, refer to Fig. 3.12.

Before a push-button set is refitted, it is advisable to stick the two parts of the clamping device together by means of adhesive tape or non-hardening glue, in order to facilitate the replacement.

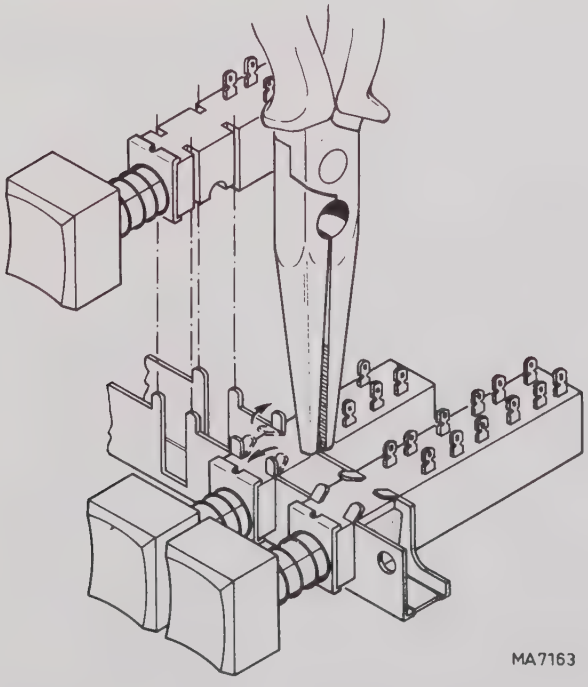


Fig. 3.12. Replacing a switch of a push-button set

3.3.13. Removing the carrying handle

1. Remove the upper and lower cabinet plates
2. Remove the plastic strip which is snapped on to the grip
3. Remove the two screws which secure the grip to the right-hand bracket
4. Remove the two hexagonal bolts which secure the right-hand bearing to the side strip
5. Depress the push-button of the right-hand bracket and take the bearing from the bracket.
6. Remove the grip from the remaining bracket
7. Depress the push-button of the left-hand bracket and turn the latter as far as possible to the lower side of the instrument
8. Keep the push-button depressed and pull the bracket from its bearing

3.3.14. Special tools

ATTENTION: When you are soldering inside the instrument it is essential to use a low-voltage soldering iron, the tip of which must be earthed to the mass of the oscilloscope.

3.3.14.1. Soldering iron for semi-conductors in micro-miniature encapsulations (SOT23)

Because of the small dimensions of these SOT23 semi-conductors and the lack of space between the components on the printed-wiring board, it is necessary to use a miniature soldering iron with a pin-point tip (max. dia 1 mm) to solder a SOT on to a printed-wiring board.

Work method:

– Unsolder pin A (Fig. 3.13)

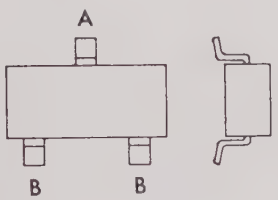


Fig. 3.13. SOT23 transistor

– Unsolder pins B and remove the SOT from the printed-wiring board
– Remove the superfluous solder and smooth down the soldering spots on the printed-wiring board. In this way, all three connection pins of the SOT are in contact with the printed conductors at the same time and damage to the SOT as a result of bending the pins, is prevented.
– Place the new SOT onto its soldering spot and keep it in place
– Solder the pins A and B to the printed-wiring board

NOTE: Bear in mind that the maximum permissible soldering time is 10 seconds during which the temperature of the pins must not exceed 250 °C. We, therefore, recommend the use of a solder with a low melting point, e.g. silver-containing solder (59 %tin, 34 % lead, 6 % silver, melting point 180 °C, order number 5322 390 84001).

Take care not damage the plastic encapsulation of the SOT during the soldering procedure (softening point of the plastic is 150 °C).

A suitable soldering-iron is e.g.
Low Voltage Mini Soldering Iron, Type 800/12 W - 6 V, power 12 W, voltage 6 V, order no. 4822 395 10004, in combination with 1-mm-pin-point tip, order no. 4822 395 10012.

3.3.14.2. Special tool for the slotted nut of attenuator switches A and B, order no. 5322 395 54023

For those who want to make such a tool, we give a sketch with the dimensions in mm in Fig. 3.14. The material is silversteel N094, tempered 40-45 Rc.

3.3.14.3. Special tool for the slotted nut of the POSITION and LEVEL/SLOPE potentiometer, order no. 5322 395 54024

For those who want to make such a tool, we give a sketch with the dimensions in mm in Fig. 3.15. The material is silversteel N094, tempered 40-45 Rc.

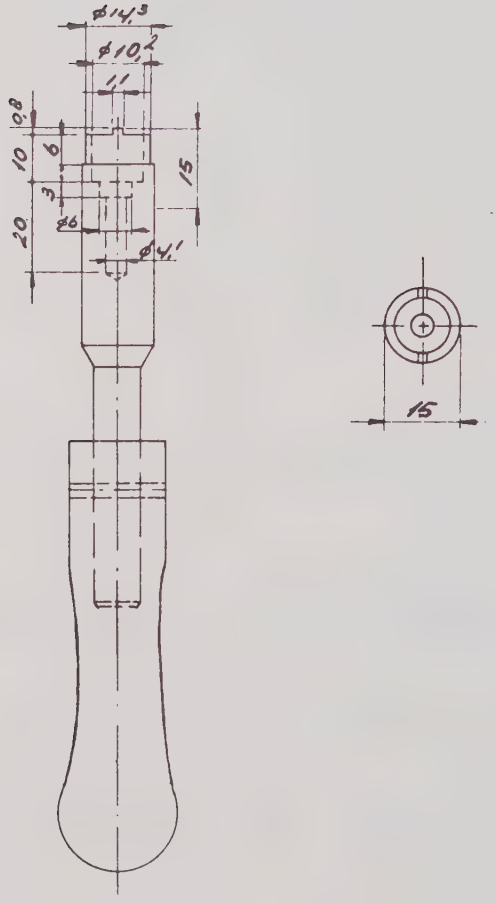


Fig. 3.14. Tool for attenuator unit order nr. 5322 395 54023

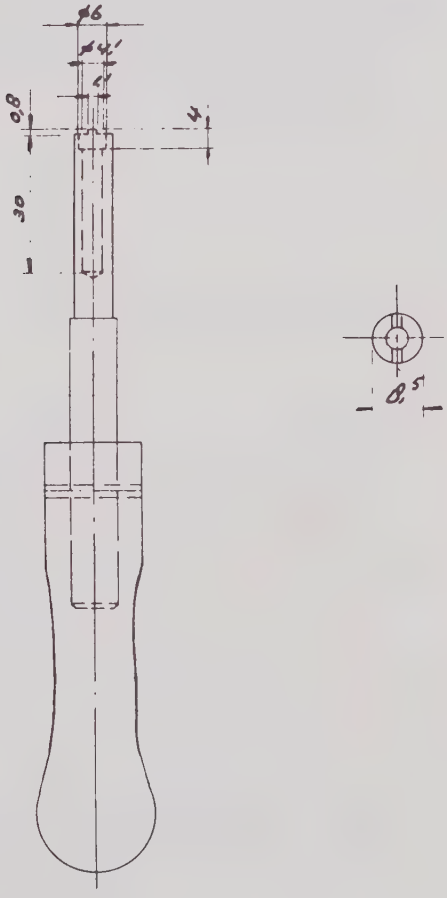


Fig. 3.15. Tool for positioning potentiometer order nr. 5322 395 54024

3.4. CHECKING AND ADJUSTING

3.4.1. General information

Refer also to 3.3.1.
The following information provides the complete checking and adjusting procedure for the PM 3265 oscilloscope. As various control functions are interdependent, a certain order of adjustment is often necessary. The procedure is, therefore, presented in a sequence which is best suited to this order, cross-reference being made to any circuit which may affect a particular adjustment. Before any check or adjustment, the instrument must attain its normal operating temperature. Under average conditions this will be approximately 30 minutes after switching on.

All controls that are mentioned without item numbers are located on the front panel of the oscilloscope.

3.4.2. Recommended test equipment

Digital multimeter, e.g. PHILIPS type PM 2421 or PM 2422A.
Pulse generator, rise time $\leqslant$ 1 ns, e.g. Tektronix type 106 or 284.
Constant amplitude signal generator, e.g. Tektronix type 067.0532.01.
R.C. Standardizer, 1 MOhm//15 pF, e.g. Tektronix type 067.0537.00.
Time-marker generator, e.g. Tektronix type 2901.
Oscilloscope with $\geqslant$ 250 MHz bandwidth e.g. PM 3400.

3.4.3. Preliminary control settings

- Depress push-buttons NORM of the polarity controls.
- Depress push-buttons DC of the signal-coupling controls.
- Set the DELAY TIME control to 0 (fully anti-clockwise).
- Depress push-button MAIN TB of the horizontal-deflection controls.
- Push the TB MAGN control to position x1.
- Depress push-buttons STARTS and AUTO of the trigger-mode controls.
- Set the MAIN TIME/DIV switch to 1 ms and the DEL'D TIME/DIV switch to OFF.
- Set the continuous TIME/DIV controls to CAL.
- Depress push-buttons DC of the trigger-coupling controls.
- Depress push-buttons A of the trigger-source controls.

3.4.3.1. If necessary, check the power supply voltages first, refer to 3.4.9.

3.4.4. Cathode-ray tube circuit

3.4.4.1. Focus and astigmatism

- Depress push-button A of the display-mode controls.
- Depress push-button MAIN TB of the horizontal-deflection controls.
- Apply a sine-wave signal at a frequency of 100 kHz to input A.
- Adjust the display height to 6 div, using the AMPL switch and vernier.
- Set the MAIN TIME/DIV switch and the LEVEL potentiometer to such a position that several complete cycles are displayed.
- Set the INTENS potentiometer for normal brilliance.
- Check that a reasonably sharp trace can be obtained with the aid of the FOCUS potentiometer. If necessary, readjust potentiometer R579 (ASTIGM) on the H.T. converter board.
- Increase the trace brilliance using the INTENS potentiometer.
- Check that still a sharp trace can be obtained with the aid of the FOCUS potentiometer.

3.4.4.2. Brilliance

- Depress push-button A of the display-mode controls.
- Depress push-button DEL'D TB of the horizontal-deflection controls.
- Turn the INTENS potentiometer clockwise.
- Set the MAIN TIME/DIV switch to 1 ms and the DEL'D TIME/DIV switch to 1 μs.
- Depress push-button 0 of the signal-coupling controls.
- Check that the dot at the start of the trace is just visible.
  If necessary, readjust potentiometer R547 (INTENSITY) on the horizontal output-amplifier and Z amplifier circuit board.

– Set the MAIN TIME/DIV switch to 0.02 μs and the DEL'D TIME/DIV switch to OFF.
– Depress push-button MAIN TB of the horizontal-deflection controls.
– Pull the TB MAGN switch to x10.
– Set the INTENS potentiometer for normal brilliance.
– Check that the brilliance is uniform over the entire trace.
If necessary, readjust trimmers C509 and C545 (BLANK. PULSE) located on the horizontal output-amplifier and Z-amplifier circuit board.

3.4.4.3. Intensity ratio

– Depress push-button A of the display-mode controls.
– Depress push-button MAIN TB of the horizontal-deflection controls.
– Turn the DELAY TIME control to 5.0 (mid-position).
– Set the MAIN TIME/DIV switch to 1 ms and the DEL'D TIME/DIV switch to .2 ms.
– Depress push-button AC of the signal-coupling controls.
– Apply a sine-wave signal at a frequency of 100 kHz to input A.
– Set the display height to 6 div.
– Set the INTENS potentiometer to a position 90° from the anti-clockwise stop.
– Check that the trace of the main time-base generator is just visible over the entire screen and that the part determined by the delayed time-base generator is more brilliant. If necessary, readjust the INTENS RATIO potentiometer R1498 on the X deflection selection circuit board.

3.4.4.4. Trace rotation

– Depress push-button A of the display-mode controls.
– Depress push-button MAIN TB of the horizontal-deflection controls.
– Centre the time-base line, using the POSITION controls.
– Check that the time-base line runs exactly in parallel with the horizontal lines of the graticule; if necessary, readjust TRACE ROT potentiometer R589 on the intermediate amplifier circuit board.

3.4.4.5. Shift correction

– Depress push-button A of the display-mode controls.
– Depress push-button MAIN TB of the horizontal-deflection controls.
– Connect a d.c. voltmeter to the vertical-deflection plates.
– Set the channel A POSITION potentiometer to obtain a voltage of 0 V (±300 mV) between the deflection plates.
– Check that the time-base line is displayed exactly in the centre of the screen; if necessary, readjust SHIFT CORR. potentiometer R588 on the intermediate-amplifier circuit board.

3.4.4.6. Orthogonality

– Depress push-button ALT of the display-mode controls.
– Depress push-button MAIN TB of the horizontal-deflection controls.
– Depress push-button 0 of the channel A signal-coupling controls.
– Set the MAIN TIME/DIV switch to 1 ms and the DEL'D TB switch to 5 μs/DIV.
– Set the channel B AMPL switch to 5 mV/DIV and its vernier control to CAL.
– Apply a sine-wave voltage of 120 mV, frequency 100 kHz, to input B.
– Centre the intensified part, using the DELAY TIME control.
– Centre the channel A time-base line, using the channel A POSITION potentiometer.
– Check that the angle between the horizontal and vertical line is 90° see Fig. 3.16. if necessary, readjust X-Y CORR potentiometer R587 on the intermediate-amplifier board.
– Check also trace rotation (chapter 3.4.4.4.).

3.4.4.7. Geometry (= Barrel-pin cushion distortion)

– Depress push-button A of the display-mode controls.
– Depress push-button MAIN TB of the horizontal-deflection controls.
– Apply a sine-wave voltage at a frequency of approx. 100 kHz to input A.
– Set the AMPL. controls to obtain a display of 7,4 div.
– Apply a sine-wave voltage at a frequency of approx. 50 Hz to input B.
– Depress push-button EXT X DEFL of the horizontal-deflection controls.
– Set the channel B AMPL switch and the X AMPL control to obtain a display width of 9,4 div.
– Check that the edges of the display lie within the hatched area shown in Fig. 3.17; if necessary, readjust the GEOMETRY potentiometer R568 on the H.T. converter board.

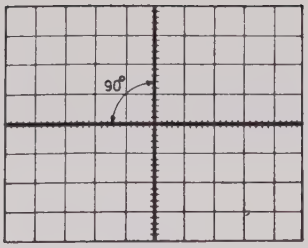


Fig. 3.16. Orthogonality check

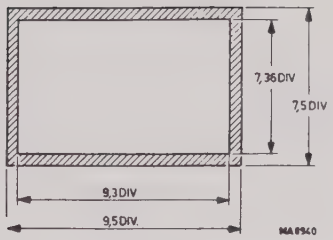


Fig. 3.17. Geometry check

3.4.5. Vertical deflection

3.4.5.1. Balance

1. Attenuator Balance:

- Depress push-button A (B) of the displaymode controls.
- Centre the time-base line, using the POSITION control.
- Turn the AMPL. switch between 0.5 V/DIV, 0,2 V/DIV and 0,1 V/DIV.
- Check that the trace does not jump more than 0,3 DIV; if necessary, adjust the BAL potentiometer R15. (Balance control on the front panel).

2. DC/O Balance

- Set the Ampl. Switch to 5 mV/DIV.
- Depress alternately the DC and O coupling switch and adjust for min. jump with R129.

3. Gain balance and additional shift compensation

Before adjusting the Gain Balance and additional shift compensation, first check D.C. Balance and Att. Bal.

- Y input switch to position 0.
- Connect a floating d.c. mV meter between points 11 and 15 of IC304 (for Ch. B: IC204).
- Adjust GAIN BAL preset potm. R311 (Ch. B: R211) until this voltage is as low as possible; max. 1 mV.
- Rotate the relative Y input AMPL vernier control and adjust R220A (Ch. B: R220B) so, that the line-shift is as low as possible.
- If necessary repeat.

4. Polarity balance

Before adjusting the Polarity Balance; the D.C. Balance, Att. Bal. and the Gain Balance must be adjusted in accordance with previous sections.

- Check that the time-base line does not shift more than 0,3 DIV when push-button INVERT of the polarity controls is depressed; if necessary, readjust POL BAL potentiometer R353 (R253) on the intermediate-amplifier board.

5. D.C. Balance Y-output

- Centre the time-base line using the position control.
- Connect a DC voltmeter to the Y-output (rear of the instrument).
- Adjust the DC balance on the rear panel so that the voltage is zero volts (±10 mV).

6. Gain Balance Attenuator

Apply a square-wave-voltage of approximately 120 mV at 20 mV/DIV of 100 Hz. Coupling switch in position DC. Adjust the GAIN potentiometer R132 such that the square-wave response is correct.

3.4.5.2. Gain

- Depress push-button A (B) of the display-mode controls.
- Depress push-button NORM of the polarity controls.
- Set the AMPL switch to .5 V/DIV.
- Set the AMPL vernier control to CAL.
- Depress push-button DC of the signal-coupling controls.
- Apply a square-wave voltage of 200 Hz with an amplitude of exactly 3 V to input A (B).
- Check with an auxiliary oscilloscope the Y-output at the rear for exactly 50 mV/div (loaded with 50 Ω) if necessary, adjust with the gain (front) control.

– Check that the display height is exactly 6 div. If necessary adjust R432 (Final Amplifier). Check that the display height is more than 6,5 div. with gain (front) control complete clock-wise.
– Check that the control range of the AMPL vernier control is at least 1:2,5.

3.4.5.3. Frequency response of vertical amplifiers

In the following section the three stages are checked: Final Y amplifier, Intermediate amplifier, Attenuators. For adjustment of the final Y amplifier first the channel-selector chopper output voltage is used as a calibration signal.
The channel selector is controlled by an external variable frequency square-wave generator which is connected to the ALT control socket on the intermediate amplifier circuit board.
Later on, the final Y amplifier, in combination with intermediate amplifier and attenuators is calibrated with the aid of a $\leqslant$ 1 ns rise time pulse.

1. Final Y amplifier

For good h.f. response check also the filter-coils which are mounted in the c.r.t. Y deflection pins (check the pins for clean contact).

– Depress push-button ALT of the display-mode controls.
– Depress push-buttons COMP of the trigger-mode controls.
– Set the POSITION controls to obtain a distance of 6 div between both time-base lines.
– Remove the main-time base connector from the alternate-control pulse socket on the intermediate-amplifier board.
– Connect the square-wave generator to the alternate-pulse socket via a 330 ohm resistor.
– Set the output voltage of the square-wave generator to approx. 1 V pos.
– Both time-base lines will be displayed alternately at a frequency determined by the frequency of the square-wave voltage.

1 kHz, R407
– Set the generator frequency to 1 kHz.
– Set the main-time base controls to obtain a suitable, triggered display.
– Check that the top of the displayed pulse is straight; if necessary, select a different value for resistor R407.

10 kHz, R403, C402
– Set the generator frequency to 10 kHz.
– Set the main-time base controls to obtain a suitable, triggered display.
– Check that the top of the displayed pulse is straight; if necessary, select a different value for resistor R403 and capacitor C402.

100 kHz, R404, C403
– Set the generator frequency to 100 kHz.
– Set the main-time base controls to obtain a suitable, triggered display.
– Check that the top of the displayed pulse is straight; if necessary, adjust potentiometer R404.

1 MHz, R406, C404
– Remove the external generator.
– Depress push-button CHOP of the display mode controls.
– Centre both time-base lines to obtain one line.
– Reconnect the ALT control pulse plug to its relevant socket.
– Set the main time base controls to obtain a suitable triggered display.
– Check that the displayed line is straight; if necessary, adjust potentiometer R406.

2. Intermediate amplifier

To be sure that the intermediate amplifier is driven by the correct signal, first the attenuator is checked.

– Depress push-button NORM of the polarity controls.
– Depress push-button DC of the signal-coupling controls.
– Set the AMPL vernier control to CAL.
– Set the AMPL switch to 10 mV/DIV.
– Apply a square-wave voltage with a rise time $\leqslant$ 200 ns and a frequency of approx. 20 kHz to input A (B).
– Set the amplitude of the input signal to obtain a trace height of 6 div.
– Connect an oscilloscope to the attenuator output: point 12 of IC202 (IC302) on the Intermediate amplifier board.
– Check that the top of the displayed pulse is straight; if necessary, readjust the attenuator.

– If required, the frequency correction of the intermediate amplifier is possible with correction networks connected between points 13 and 15 of Amplifier I and between points 12 and 14 of Amplifier II. Start always with the longest RC time network, with a square wave voltage of 1 kHz and increase to 10 kHz, 100 kHz and 1 MHz.

3. H.F. overall Response

1 MHz, R323 (R223), R408, R409, R410, C407
– Depress push-button A (B) of the display-mode controls.
– Depress push-button NORM of the polarity controls.
– Set the AMPL switch to 10 mV/DIV.
– Apply a square-wave voltage with a rise time of $\leqslant$ 1 ns and a frequency of 1 MHz to input A (B).
– Set the MAIN TIME/DIV switch to 0.1 μs.
– Pull the TB MAGN switch x10.
– Check that there is an optimum pulse response; if necessary, adjust R323 (A) and R223 (B) on the intermediate amplifier board and R408, 409, 410 and C407 on the final amplifier board, at the same time readjusting TERMINATION potentiometer R423.

After this adjustment check the gain as follows:
– Set the generator frequency to 1 kHz.
– Set the generator output voltage to 60 mV.
– Check with an auxiliary oscilloscope the 50 Ω Y output for exactly 300 mV.
– Check that the trace height is 6 div, if necessary, readjust potentiometer R432 on the final Y amplifier board.

4. Multiplier, Balance, H.F. corrections, Gain, Bandwidth and Noise reduction.

Pol. Balance
– Depress push-button MULT. of the display-mode controls.
– Depress alternately NORM/INVERT for channel B or A and adjust for min. jump with R276.

H.F. Corrections
– Depress push-buttons DC for both A and B input-coupling controls.
– Set the Ampl. Switch for both A and B to 10 mV/DIV.
– Apply a DC voltage of ±10 mV to input B.
– Apply a square-wave voltage of 40 mV^{p-p} to input A with the following frequencies:

100 Hz	Check for correct response
1 kHz	Check for correct response
10 kHz	Check for correct response
100 kHz	Check for correct response.

If necessary select different values for the HF correction elements C267 and R393, C266 and R392, C264 and R391.
Correction of the leading edge with C241. For the highest frequencies adjust R272.

Multiply Offset compensation (OxA), (OxB)
– Apply a 80 mV^{p-p} sine wave voltage 50 kHz to input A at 10 mV/DIV setting.
Depress push-button O for the input-coupling controls for channel B.
Adjust with front-panel potentiometer OxA to minimum.
– Apply a 80 mV^{p-p} sine-wave-voltage, 50 kHz, to input B at 10 mV/DIV setting.
Depress push-button O for the input-coupling controls for channel A.
Adjust with front-panel potentiometer OxB to minimum.

Multiply Gain
Input A and B at 10 mV/DIV and DC coupling.
Apply to the A input a sine-wave-voltage 50 kHz of 40 mV^{p-p}.
Apply to the B input a DC voltage of exactly 10 mV.
Adjust the multiply gain (front panel) control to a product of exactly 4 div.

Multiply Bandwidth
– Both Attenuators to 10 mV/DIV.
– Apply to input A a constant sine-wave-voltage of 40 mV.
Apply to input B a DC voltage of 20 mV.
The upper limit where the bandwidth falls down to –3 dB must be $\geqslant$ 100 MHz.

– Apply to input B a constant sine wave voltage of 40 mV.
Apply to input A a DC voltage of 20 mV.
The upper limit where the bandwidth falls down to –3 dB must be ⩾ 100 MHz.

Noise reduction

– Noise reduction with bandwidth limitation is possible by connecting rc networks on the output of amplifier III (12 and 14).

5. H.F. compensation Y output

– Connect an oscilloscope with 50 Ω input impedance to the Y output on the rear.
– Apply a square-wave voltage at channel A of 6 div at 10 mV/DIV, DC coupling.

100 Hz	Check for correct response
1 kHz	Check for correct response
10 kHz	Check for correct response
100 kHz	Check for correct response, if necessary select a different value for C259 and readjust R292. Correction of the leading edge with C261.

– Check the bandwidth with a constant sine wave voltage up to the –3 dB point which must be ⩾ 150 MHz.

6. Attenuator

– Depress push-button A (B) of the display-mode controls.
– Depress push-button NORM of the polarity controls.
– Depress push-button DC of the signal-coupling controls.
– Apply a square-wave voltage with a rise time ⩽ 200 ns and a frequency of 20 kHz to input A (B).

Frequency compensation

– Set the AMPL switch to the positions indicated in the following table, at the same time setting the input amplitude to the appertaining value.
– Check that there is a correct display of the input signal; if necessary, readjust the relevant trimmer.

AMPL switch to	Signal at input A (B)	Adjust with
.1 V/DIV	600 mV	C101
1 V/DIV	6 V	C109

Input capacitance

– Apply the square-wave input voltage (rise time ⩽ 200 ns, frequency 20 kHz) to input A (B) via an RC Standardizer of 1 MOhm//15 pF.
– Set the AMPL switch to the positions indicated in the following table, at the same time setting the input amplitude to the appertaining value.
– Check that there is a correct display of the input signal; if necessary, readjust the relevant trimmer.

AMPL switch to	Signal at input A (B)	Adjust with
10 mV/DIV	60 mV	C107
.1 V/DIV	600 mV	C102
1 V/DIV	6 V	C111

3.4.5.4. Chopping

– Depress push-button CHOP of the display-mode controls.
– Depress push-button MAIN TB of the horizontal-deflection controls.
– Set the MAIN TIME/DIV switch to 0.2 μs.
– Check that there are two time-base lines displayed which can be shifted in relation to one another by means of the POSITION controls.
– Set the POSITION potentiometers to obtain a distance of 3 div between the two lines.
– Depress push-button EXT of the main time-base trigger-source controls.
– Apply the chopper signal (available at point 6 of IC1602 on the intermediate amplifier circuit board) to the EXT input of the main time-base. It is then possible to trigger the time-base generator with the chopper frequency.

– Set the LEVEL potentiometer for a triggered display.
– Check that the chopper frequency is approx. 1 MHz.
– Check that each signal is displayed for approx. 300 ns.
– Check that the trace is blanked during the channel-switching.
– Check that this blanking time is approx. 200 ns.

3.4.5.5. Common mode rejection

– Depress push-button ADD of the display-mode controls
– Depress the INVERT push-button of the channel B signal-polarity controls
– Set the AMPL switches to 5 mV/DIV
– Apply a sine-wave voltage simultaneously to sockets A and B
– Check the rejection in accordance with the following table

Note: Adjust the continuous AMPL control of channel A or channel B for minimum trace height

Input voltage	Generator frequency	Max. trace height	Rejection factor
120 mV	100 kHz	0,24 DIV	> 100
120 mV	2 MHz	0,24 DIV	> 100
120 mV	50 MHz	1,20 DIV	> 20

– Disconnect the input voltage

3.4.6. Triggering

When checking and adjusting the trigger amplifiers, bear in mind that the various trigger circuits are interdepending as shown in the block diagram.

3.4.6.1. Trigger amplifiers (channel A and B) on intermediate amplifier circuit board

1. Shift
   – Depress push-button O of the channel A (B) signal-coupling controls.
   – Measure the voltage between points C and D (A and B).
   – Check that the voltage is 0 V ±10 mV; if necessary, readjust SHIFT potentiometer R301 (R201).

2. Zero level

   Before checking the zero level, the trigger amplifier must be checked in accordance with the previous section.

   – Depress push-button O of the channel A (B) signal-coupling controls.
   – Measure the voltage between point D (B) and earth.
   – Check that the measured voltage is 0 V ±10 mV; if necessary, readjust ZERO LEVEL potentiometer R304 (R204).

3.4.6.2. Trigger amplifier of the main time-base

Before checking and adjusting the trigger amplifier of the main time-base, the trigger amplifiers of channels A and B must be checked in accordance with the previous section.

1. Level
   – Depress push-button MAIN TB of the horizontal-deflection controls.
   – Depress push-button DC for channel A.
   – Depress push-button DC of the trigger-coupling controls.
   – Connect a sine-wave-voltage with 6 div. at 0,2 V/DIV, 100 kHz to the A input (B).
   – Set the TIME/DIV switch such that several cycles are displayed.
   – Change the slope switch between + and –. Adjust R737 (Trigg. sens.) for a gap of 0,2 div. between the trigger starting points.
   – Set the ATT switch to 2 V/div.; triggering must be possible with this 0,6 div signal. If necessary, readjust R737.
   – Depress push-button HF of the trigger-coupling controls.
   – Connect test point C to earth. (Base of TS637).
   – Shift with R709 (level) the trigger start point symmetrically around the zero line of the sine wave.

– Depress push-button DC of the trigger-coupling controls.
– Depress push-button A (B) (Comp.) of the trigger source controls.
– Check that the trigger start point is symmetrical around the zero-line of the sine-wave by changing the SLOPE switch from + to –; if necessary, readjust YA (YB) (COMP.) potentiometer R636 (R656), (R659).
– Depress push-button EXT of the trigger-source controls.
– SK24 depressed. (X AMPL/HOLD OFF KNOB).
– Connect the same input voltage of the Y channel to the EXT input.
Shift with R625 the trigger start point symmetrically around the zero-line of the sine wave.
– Remove earth connection from testpoint C.

2. L.F.

This control (R712) compensates for equal gain of the lf- and hf path of the trigger amplifier circuit. In this procedure a signal is applied to ch. A input, while the signal in the trigger circuit is shown on ch. B.

– Depress push-button B of the display-mode controls.
– Depress push-button NORM of the polarity controls.
– Depress push-button DC of the channel A signal-coupling controls.
– Depress push-button AC of the channel B signal-coupling controls.
– Depress push-button A of the trigger-source controls.
– Set the AMPL switch of channel A to 20 mV/DIV and the AMPL switch of channel B to 0.1 V/DIV.
– Apply a square-wave voltage of 120 mV, frequency 30 kHz, to input A.
– Apply the signal of test point A (TS634) or B (TS642) to channel B input.
– Set LEVEL control on the frontpanel for maximum signal to channel B.
– Check that the top of the displayed pulse is straight; if necessary, readjust LF GAIN potentiometer R712.
– Depress push-button LF of the trigger-coupling controls.
– Check that the displayed pulse is shaped as shown in Fig. 3.18.
– Depress push-button Hf of the trigger-coupling controls.
– Check that the displayed pulse is shaped as shown in Fig. 3.19.

3.4.6.3. Trigger amplifier of the delayed time-base

1. Level

– Depress push-button DEL'D TB of the horizontal-deflection controls.
– Depress push-button DC for channel A.
– Depress push-button DC of the del'd tb trigger-coupling controls.
– Set the TIME/DIV switch such that several cycles are displayed.
– Connect a sine voltage with 6 div. at 0,2 V/DIV 100 kHz to the A input (B).
– Change the slope switch between + and –. Adjust R1137 (TR GAIN) for a gap of 0,2 div. between the trigger starting points.
– Set the ATT switch to 2 V/DIV; triggering must be possible with this 0,6 div. signal. If necessary, readjust R1137.
– Depress push-button HF of the trigger-coupling controls.
– Connect test point C to earth (Base of TS1039).
– Shift with R1109 (level) the trigger start point symmetrically around the zero line of the sine wave.
– Depress push-button DC of the trigger-coupling controls.
– Depress push-button A (B) of the trigger-source controls.
– Check that the trigger starting point is symmetrical around the zero-line of the sine wave by changing the slope switch from + to –.
If necessary, readjust YA (YB) potentiometer R1036 (R1056).
– Depress push-button EXT of the trigger-source controls.
– Check that the trigger starting point is symmetrical around the zero-line of the sine wave by changing the slope switch from + to –.
If necessary, readjust EXT potentiometer R1025.
– Remove earth connection from testpoint C.

2. L.F. Gain

This control (R1112) compensates for equal gain of the lf- and hf path of the trigger amplifier circuit.
In this procedure a signal is applied to ch. A input while the signal in the trigger circuit is shown on ch. B.

- Depress push-button B of the display-mode controls.
- Depress push-button NORM of the polarity controls.
- Depress push-button DC of the channel A signal-coupling controls.
- Depress push-button AC of the channel B signal-coupling controls.
- Depress push-button A of the trigger-source controls of the delayed-time base.
- Set the AMPL switch of channel A to 20 mV/DIV and the AMPL switch of channel B to 0.1 V/DIV.
- Apply a square-wave voltage of 120 mV, frequency 30 kHz, to input A.
- Apply the signal of testpoint A (TS1042) or B (TS1034) to ch. B input.
- Set LEVEL control on the front panel for maximum signal to ch. B.
- Check that the top of the displayed pulse is straight; if necessary, readjust LF GAIN potentiometer R1112.
- Depress push-button LF of the trigger-coupling controls of the delayed time-base.
- Check that the displayed pulse is shaped as shown in Fig. 3.18.
- Depress push-button HF of the trigger-coupling controls.
- Check that the displayed pulse is shaped as shown in Fig. 3.19.

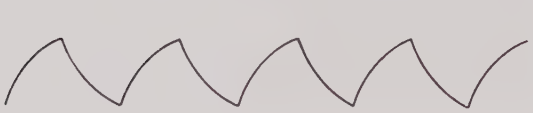


Fig. 3.18. LF trigger coupling

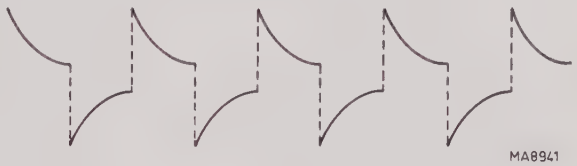


Fig. 3.19. HF trigger coupling

3.4.7. Sweep circuits

3.4.7.1. Main time-base

1. Stability

- Depress both O push-buttons of the signal-coupling controls.
- Depress push-button MAIN TB of the horizontal-deflection controls.
- Depress push-button TRIG of the trigger-mode.
- Set the DEL'D TIME/DIV switch to OFF.
- Rotate the LEVEL control fully anti-clockwise.
- Turn STAB potentiometer R806 fully clockwise.
- Rotate STAB potentiometer R806 anti-clockwise approx. 20° past the point where the time-base line ceases to be displayed.
- Depress push-button AUTO of the trigger-mode and check if the sweep circuit is running.

2. Time coefficients

As the power supply may affect the sweep times, it must be checked when the sweep times are not correct.

- Connect a time marker generator to an Y input.
- Depress push-button MAIN TB of the horizontal-deflection controls.
- Push the TB MAGN control to position x1.
- Set the MAIN TIME/DIV switch to 0.1 ms.
- Apply a time-marker signal of 0,1 ms.
- Check that the 8 centre cycles cover exactly 8 div; if necessary, readjust X1 potentiometer R1462.
- Pull the TB MAGN control to position X10.
- Set the time-marker generator to 10 μs.
- Check that the 8 centre cycles cover exactly 8 div; if necessary, readjust X10 potentiometer R1454.
- Set the Time-marker to 2 ns.
- Set the MTB switch to 0,02 μs/DIV.
- Adjust with R1512 for 1 Marker/div (X position potm. middle position), see also linearity.
- Set the MAIN/TIME/DIV switch to 10 ms.
- Push the TB MAGN control to position X1.
- Set the time-marker generator to 10 ms.
- Check that for the 8 centre cycles a display of one cycle per div is obtained; if necessary, readjust 10 ms potentiometer R834.
- Check the sweep times in all other positions of the MAIN TIME/DIV switch.

3. Linearity

- Depress push-button MAIN TB of the horizontal-deflection controls.
- Pull the TB MAGN control to position X10.
- X position potm. middle position.
- Depress push-button AUT of the trigger-mode controls.
- Set the MAIN TIME/DIV switch to 0,02 μs.
- Time-marker signal 2 ns.
- Check that the 8 centre cycles cover 8 div; if necessary, readjust trimmers C1703 and C1707 on the final X- and Z-amplifier board.

3.4.7.2. Delayed time-base

1. Stability

- Depress push-button O of the signal-coupling controls.
- Set the DELAY TIME control to zero.
- Depress push-button DEL'D TB of the horizontal-deflection controls.
- Depress push-button TRIG of the DEL'D TB trigger-mode controls.
- Depress push-button AUT of the MAIN TB trigger-mode controls.
- Set the MAIN TIME/DIV switch to 0.2 ms and the DEL'D TIME/DIV switch to 0.1 ms.
- Rotate the del'd tb LEVEL control fully anti-clockwise.
- Rotate STAB potentiometer R1206 on the delayed time-base board fully anti-clockwise.
- Rotate STAB potentiometer R1206 clockwise approx. 20° past the point where the time-base line ceases to be displayed.

2. Time coefficients

- Connect a time marker generator to ch. A input.
- Set the DELAY TIME control to zero.
- Depress push-button DEL'D TB of the horizontal-deflection controls.
- Depress push-button TRIG of the DEL'D TB trigger-mode controls.
- Depress push-button AUTO of the MAIN TB trigger-mode controls.
- Set the MAIN TIME/DIV switch to 0.2 ms and the DEL'D TIME/DIV switch to 0.1 ms.
- Depress push-button DC of the del'd tb trigger-coupling controls.
- Depres push-button A of the del'd tb trigger-source controls.
- Apply a time-marker signal of 0.1 ms.
- Check that the 8 centre cycles cover exactly 8 div; if necessary, readjust 0.1 ms potentiometer R1227.
- Set the MAIN TIME/DIV switch to 20 ms and the DEL'D TIME/DIV switch to 10 ms.
- Set the time-marker generator to 10 ms.
- Check that the 8 centre cycles cover exactly 8 div; if necessary, readjust 10 ms potentiometer R1234.
- Set the Time-marker to 2 ns.
- Set the Delayed Time/Div to 0,02 μs/DIV.
- Pull the TB MAGN control to position X10.
- X position potmeter middle position.
- Adjust with R1517 for 1 Marker/Div.
- Check the sweep times in all other positions of the DEL'D TIME/DIV switch. Keep during this check the DELAY TIME control fully anti-clockwise and the MAIN TIME/DIV switch one position slower than the DEL'D TIME/DIV switch. In this way, the delayed time-base can complete an entire sweep.

3. Delay time

- Depress push-button A of the display-mode controls.
- Depress push-button DC of the signal-coupling controls.
- Depress push-button MAIN TB of the horizontal-deflection controls.
- Depress push-button AUTO and STARTS of the trigger-mode controls.
- Set the MAIN TIME/DIV switch to 1 ms and the DEL'D TIME/DIV switch to 0.5 ms.
- Turn the DELAY TIME Multiplier fully anti-clockwise.
- Adjust R1503 (DTB pos) so that the dtb starts at the same point as the mtb.
- Set the MAIN TIME/DIV switch to 0.1 ms and the DEL'D TIME/DIV switch to 0.05 μs.
- Depress push-button DC of the trigg-coupling controls.
- Depress push-button A of the trigger-source controls.
- Apply a time marker of 0.1 ms.
- Set the DELAY TIME control to 1.00.
- Check that the spot of the delayed time-base coincides with the starting point of the second time-marker pulse; if necessary, readjust START potentiometer R1514 on the switching-unit board.

– Set the DELAY TIME control to 9.00.
– Check that the spot of the delayed time-base coincides with the starting point of the tenth time-marker pulse; if necessary, readjust STOP potentiometer R1513 on the switching-unit board.

As the START and STOP adjustments are slightly interdependent, they must be repeated until both conditions are fulfilled.

4. Alternate Time-base

Check that with the Trace Sep. (front control) separation of min. 4 div can be obtained, if necessary adjust with R1657.

3.4.8. Horizontal deflection

3.4.8.1. Balance of the horizontal amplifier

If necessary, first check trigger amplifiers on the intermediate amplifier circuit board.

– Depress push-button MAIN TB of the horizontal-deflection controls.
– Push the TB MAGN control to X1.
– Set the X POSITION control to such a position, that the time-base line starts at the first vertical graticule line.
– Depress push-button EXT X DEFL of the horizontal-deflection controls.
– Depress push-button A of the X deflection-source controls.
– Check that the spot does not move more than 0.3 DIV when the X AMPL potentiometer is rotated clockwise and anti-clockwise; if necessary, readjust POS potentiometer R1401 on the switching-unit board.
– Check that after this adjustment the spot lies within one div from the screen centre.

3.4.8.2. X Deflection via channel A

– Depress push-button B of the display-mode controls (the vertical A channel is now blocked).
– Set the channel A AMPL switch to 0.5 V/DIV.
– Depress push-button AC of the signal-coupling controls.
– Depress push-button EXT X DEFL of the horizontal-deflection controls.
– X ampl control (R22) in the cal. position..
– Depress push-button A of the X deflection-source controls.
– Apply a sine-wave voltage of exactly 3 V^{p-p} frequency 2 kHz to input A.
– Check that the trace length is exactly 6 div; if necessary, readjust GAIN potentiometer R1419 on the switching-unit board.

3.4.8.3. X Deflection with the mains frequency

– Depress push-button EXT X DEFL of the horizontal-deflection controls.
– Depress push-button MAINS of the X deflection-source controls.
– Check that the trace width is 8 div ±1,5 div; (mains 220 V) if necessary, readjust potentiometer R669 on the main time base circuit board.

3.4.8.4. X Deflection with external input

– X Ampl. control (R22) in cal. position and depressed.
– Apply a sine-wave voltage of 2400 mV, 2 kHz.
– Check for 8 div horizontal display.
– SK24 pulled out (Att. ÷ 3). (X AMPL. Knob)
– Apply a sine wave voltage of 7.2 V, 2 kHz.
– Check for 8 div horizontal display.

3.4.9. Power supply

Warning: Use an isolating mains transformer when working in the power supply unit.
Bear in mind that the main part of this unit is connected direct to the mains.

Attention: The power supply unit is provided with one pre-set potentiometer (R1828) which controls the d.c. output of the circuit.
Only adjust this potentiometer when strictly necessary. Adjusting this potentiometer includes that all d.c. output voltages change, so that several circuits of the oscilloscope (e.g. time base sweep) must be recalibrated.
In the factory this potentiometer has been adjusted to the nominal value of the +15 V output (measured on point 6 of the 6-pole connector of the power supply).
This voltage must be +15 V + or −200 mV.

3.4.10. Calibration unit

- Check the CAL square wave for irregularities.
- Check that the amplitude is 3 V ±0.7 %; if necessary, readjust CAL potentiometer R1906 on the intermediate-amplifier board.
- Check that the frequency of the CAL voltage is 2 kHz ±2 %.
- Check that the CAL current is 6 mA ±1 %.

3.5. TEST AND REPAIR HINTS

3.5.1. General information

Refer also to 3.3.1.

- Use an isolating transformer when measurements must be made in the power supply.
- For measuring on the printed-wiring boards, test-pins with sharp points must be used. Be careful not to cause a short-circuit by letting the test-pin slip from the test point.
- Use an appropriate soldering iron and solder with a low melting point, if micro-miniature semi-conductors must be replaced (for recommended iron and solder, refer to section 3.3.15.1.). It is essential to earth the tip of the soldering iron to the mass of the oscilloscope.
- Be very careful not to bend the pins on the neck of the c.r.t., since this is likely to result in a gas-leak.
- Do not remove or insert hybrid circuits when the instrument is switched in.
- Do not plug and unplug connectors when the instrument is switched in.
- Do not touch any trim potentiometers or trimmers before a fault has been located.

3.5.2. Y Channels

3.5.2.1. General

If there is a fault in one of the Y channels, it can easily be traced to a certain unit by combining the attenuator of one channel and the intermediate amplifier part of the other channel.
This is simply a matter of plugging coaxial cables.

3.5.2.2. Attenuator

Be careful if a reed relay must be replaced. Such a relay consists of a glass tube, containing the contact points, and a coil. The coil is fitted around the glass tube, with a piece of foil in between for shielding. Since the glass tube is rather fragile, the connection wire of the relay must be bent and soldered with caution. Do not twist the connection wires, as this may cause broken glass-metal seal and unreliable contact inside the glass-tube.

3.5.2.3. Intermediate amplifier

- When you are measuring in the intermediate amplifier, do not remove the circuit blocks.
- If the AMPL vernier control does not work, first check IC303 (for channel A) or IC203 (for channel B).
- If the chopper square-wave is asymmetrical, which shows on the screen as a difference in brilliance of the two traces in the CHOP mode, check circuit block IC208.
- If the common-mode rejection factor is too low, check IC204 and IC304.

3.5.2.4. Final amplifier

- The final amplifier unit is unaccessible for measurements when it is still inside the oscilloscope. It is, however, possible to take the unit out of the oscilloscope (refer to section 3.3.6.) and operate it there.
  The multipole connector, the 50-Ohm-cables and the delay line must remain connected. The connections to the c.r.t. are too short, but is is possible to bypass the c.r.t. filter and leave it out of the circuit. The bypass can be made by interconnecting the lead from the collector of TS401 and the lead to R420 on the amplifier board, and the lead from TS402 and the lead to R431. In this way, there is a current path and a test oscilloscope may be connected across R420 ... R431. Only l.f. and d.c. measurements are possible, of course, with this method.
- If pulse-top errors arise spontaneously, check the c.r.t. filter for interruptions and contact failure.
  Check also the c.r.t. pins on corrosion.

3.5.3. Triggering

- The input stage can be normally measured on the base of the transistors. On the collectors, however, the signal is current. On the collectors of TS603 and TS618 the signal is voltage again. We refer all the time to components of the main time-base, but the same details apply to the delayed time-base.
- The emitter of TS634 is connected to test point A and the emitter of TS642 to test point B
  The signal on these test points is voltage and can be measured with the aid of an oscilloscope.

– Test point C is connected to the base of transistor TS637. The signal on this point is also voltage.
– Test point D is connected to point 4 of IC601.
With an input signal of approx. 6 DIV applied to the oscilloscope, a square-wave can be measured on this point.
If this signal is there and the oscilloscope cannot be triggered, the presence of an output signal on point 16 of IC601 must be checked. This signal consists of very narrow negative-going spikes which are best displayed on a sampling oscilloscope. You may also measure the pulses on point 14 of the circuit block. These pulses which are positive-going and control the auto-circuit are not as steep as the ones on point 16 and as such, easier to display.
If there are pulses on point 14, you may almost take it for granted that there are also pulses on point 16.
– If there is no triggering, another fault possibility is stabistor GR606. On point 15 of IC601 is normally a voltage of 9 V, but with a faulty stabistor this voltage will be approx. 15 V.

3.5.4. Time-base generator

– The easiest way to test the time-base generator (we refer here to the main time-base generator, but a similar procedure applies to the delayed time-base) is to remove transistors TS807 and TS808, switch in a low sweep speed and short-circuit the cathode of GR801 to earth. During the time that this short-circuit exists, C807 is charged. The charging process can be traced through the time-base generator, where the changing level must be measured in all circuits.
A fault is then located at a point which does not follow the changing level.
– Transistor TS807 can be removed without disturbing the working of the time-base generator.

3.5.5. Final X amplifier

– To check the d.c. balance of this stage, you may remove transistors TS1704 and TS1706. It is not possible to remove transistors furtheron in the circuit for this measurement, since one half of the circuit has been connected to +110 V and the other half to −110 V.
– All signals in the final X amplifier are currents, but voltage can be measured on the X deflection plates. The voltage on each plate must be approx. 32 V. If one of the plate voltages shows a considerable deviation from this value, the corresponding side of the amplifier must be checked. The must likely fault would be a faulty zener diode.

3.5.6. Z Unit

– If the trace brilliance cannot be turned down with the INTENS control, transistor TS509 and diode GR505 must be checked. The cause may be the following.
If the connection wire of C522 is unplugged while the oscilloscope is operating, capacitor C522 is charged. When the cable is plugged in again, transistor TS509 and may-be diode GR505 are likely to be destroyed by the surge. So if you have disconnected the cable of C522 and you want to plug it in again, switch off the oscilloscope, discharge the capacitor, plug in the cable and switch the oscilloscope on again.
Also be very careful if the unplugged capacitor-cable is dangling about in the circuitry, because this too may cause the same damage.
– If the 2-kV-generator breaks down, check transistor TS2004.

3.5.7. Power Supply

The best way to check the power supply is, when this unit is connected to the normal circuitry of the PM 3265. Provisions have been taken that the unit, after being taken out, remains connected to the instrument. To facilitate the removal, first disconnect the various connections of the power supply unit.
For locating a possible overload or short-circuit in the various units of the oscilloscope, the supply connectors of the units may be disconnected, one at the time. Also the supply currents can be measured on each contact of these connectors. To disconnect one contact of a connector carefully press (twice) the spring at the side of the contact and lift the contact out. Inserting an additional contact provided with a piece of extension wire simplifies current measurement. After replacing the original contact check the spring locking-action to prevent the contact from coming loose later-on.

When the power supply unit is overloaded, the current limitation is actuated. As a result of this, the power supply goes in the "hiccup" mode (3-seconds cycle time approx.). This is caused by, successively, slow charging of the capacitor C1809, starting of the chopper, activation of current limiting transistor TS1808, discharging of the regulator capacitors and so on.

Another reason for the power supply going in the "hiccup" mode is, when the switching transistor TS1801 gets no base current from the regulator circuit. In this case capacitor C1809 is slowly charged until the chopper circuit starts which causes the discharge of this capacitor in a short time, and so on.

If necessary, the power supply unit only, can be checked with the aid of a dummy load, consisting of load resistors and capacitors and a 6 V pilot lamp; see Fig. 3.21.
If a fault is suspected in the power supply, the following procedure may help you to find what is wrong.

NOTE: The power supply must always be loaded with the nominal load.

Required instruments

- Variable mains transformer with isolated windings
  (e.g. Philips bench model 2422 529 00005 or
  panel model 2422 529 00006;
  input 220 V, output 0-248 V/3 A).
- Watt meter (to measure mains power input).
- Oscilloscope (5 MHz bandwidth).
- Resistor 100 Ω, 25 W (5322 115 50011).
- Resistor 22 Ω, 25 W (5322 115 50006).
- Resistors of 1 kΩ and 50 kΩ, 0.5 W.

Checking procedure

In the first part of this procedure the power supply circuit is checked while the regulating circuit is out of service. In this case always check that the voltage across C1809 never exceeds the voltage of GR1814.

- Connect the isolating/variable transformer to the mains.
  Connect the power supply in series with a 22 Ω, 25 W resistor, via a Watt meter to the isolating/variable transformer.
  Mains voltage 40 V. Remove current limiting transistor TS1808.
  Check that the sum voltage over C1809 rises to approx. 56 V within 2 or 3 seconds when the mains voltage is switched-on (the chopper circuit is not oscillating).
  The speed of the charging depends on the current-gain of TS1801.

  If this voltage over C1809 does not appear, check R1802 and check the chopper circuit on short-circuit.

- Connect a 1 kΩ resistor in parallel to the series-circuit of R1814, C1809 and check that the voltage over this capacitor drops to zero. Remove the 1 kΩ resistor and check that the voltage rises again to 56 V.
- Short circuit emittor-collector of TS1801. Keep the mains voltage on 40 V and start the chopper circuit (TS1803) by connecting for a short moment one base of TS1803 via a 50 kΩ resistor to point 4 of transformer T1802. The voltage over the 22 Ω resistor in the mains circuit must be approx. 3 V. The voltage over C1809 is then approx. 35 V.

  If the chopper does not oscillate, check the chopper circuit itself.
  If the chopper goes in the "hiccup" mode when the 50 kΩ resistor remains connected, check the d.c. output circuits of the power supply, and check the circuit connected to points 7 and 8 of T1802.
- Check the voltage on point 5 of T1802 with an oscilloscope.
  This must be a square wave of approx. 70 $V_{p\text{-}p}$, frequency approx. 17 kHz.
- Remove the 22 Ω resistor in the mains circuit.
  Increase the mains voltage until the voltage over C1809 amounts to 100 V. The chopper must start automatically.
  Check the pulse on the base of TS1801; the duty cycle of this pulse can be varied with R1828. If not, check the regulator circuit.
  Power consumption must be 50 W approx.
- Remove the short-circuit across TS1801; check that the pulse on the base of TS1801 changes at this moment.
- Fit current limiting transistor TS1808. Check whether the chopper circuit cuts out (goes in the "hiccup" mode) when the load of the power supply is increased by 50 % approx. To this end connect a 100 Ω, 25 W resistor to the +46 V output.
  There must be current limitation when power input exceeds approx. 72 W.
  Also when the +46 V output is short circuited the power supply goes in the "hiccup" mode.

– Mains voltage 90 V; if necessary adjust the +15 V output voltage (+ or – 150 mV tolerance is allowed) with the aid of R1828
Check again the voltage on point 5 of T1801 with an oscilloscope.
Frequency must be 18 to 22 kHz; check the shape of the chopper square-wave voltage.

– Vary the mains voltage between 90 and 248 V.
Check that the +15 V output remains constant (between + or – 75 mV).
Check the 50 % overload current limitation at 248 V (do not short circuit the output at 248 V mains).

WAVEFORMS IN THE POWER SUPPLY

1. Regulator input voltage versus voltage across switching transistor TS1801

a. Voltage on p3 with respect to p2 of IC1801
b. Collector-emitter voltage of TS1801; lower line is 0 V
mains voltage 220 V
PM 3251 settings: 220 mV/DIV for a; 100 V/DIV for b;
20 ms/DIV; external triggering from p5T1802.

2. Chopper

a. Voltage between p2 and p3 of transformer T1801
b. Voltage between p7 and p8 of transformer T1802
Mains voltage 220 V
PM 3251 settings: 5 V/DIV; 10 μs/DIV; external triggering from p5T1802.

3. Switching transistor TS1801

Current flowing through R1802

a. Mains voltage 110 V
b. Mains voltage 220 V
PM 3251 settings: 0.5 V/DIV (=0.4 A/DIV); 20 μs/DIV; external triggering from p5T1802.

4. Regulator input voltage at 220 V and 110 V mains voltage

Voltage on p3 with respect to p2 of IC1801
a. at 220 V
b. at 110 V
PM 3251 settings: 200 mV/DIV; 20 ms/DIV; external triggering from p5T1802.

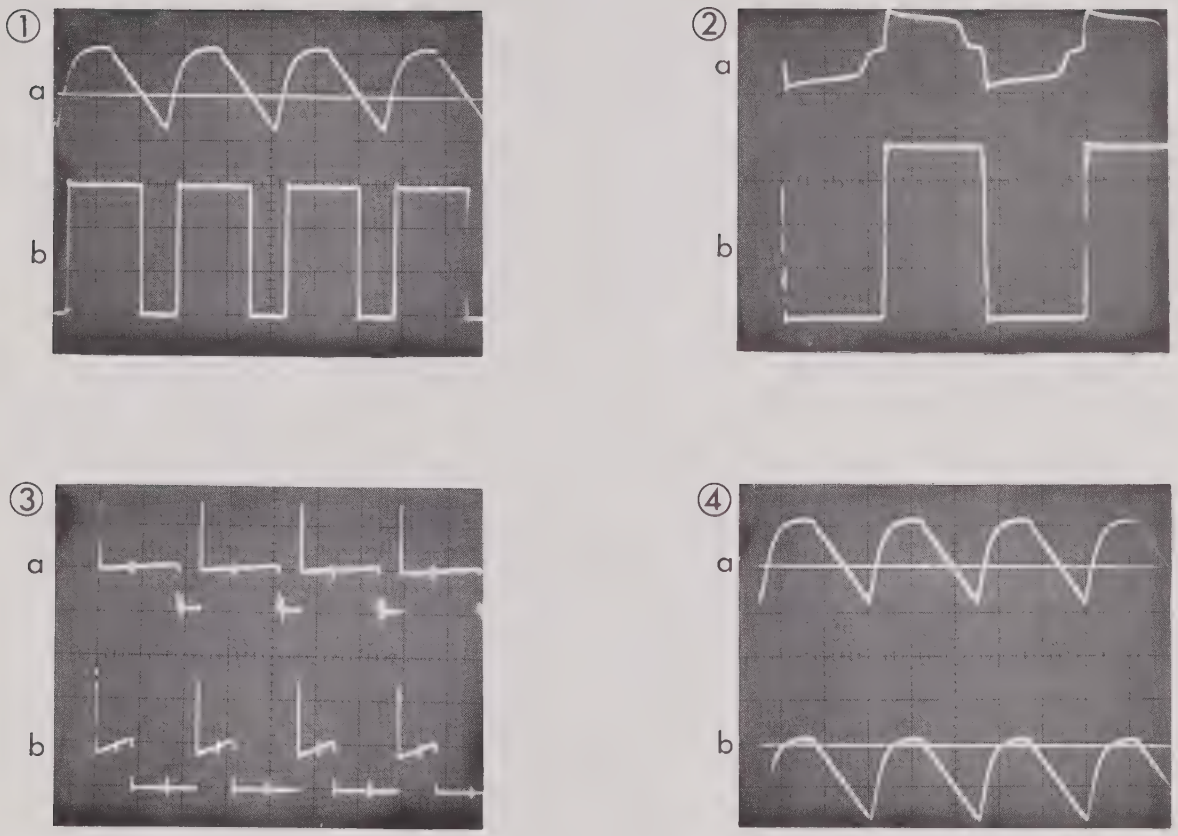


Fig. 3.20. Waveforms in the power supply

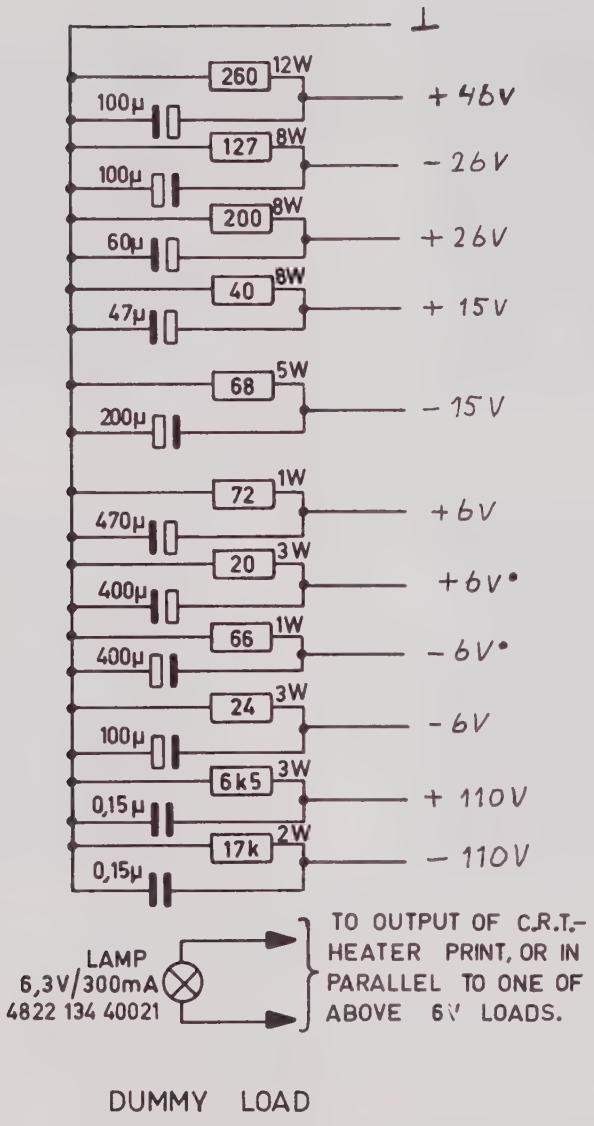


Fig. 3.21. Dummy load for power supply

3.6. MAINTENANCE

After removal (see section 3.3.) the cabinet plates may be cleaned with a mild non-abrasive houshold detergent. Do not use chemical solutions such as trichlorethylene and acetone.

The text plate may be cleaned with the same detergent, with alcohol or with white spirit. Always use a soft cloth or cotton wool.

Fig. 3.22. Front view

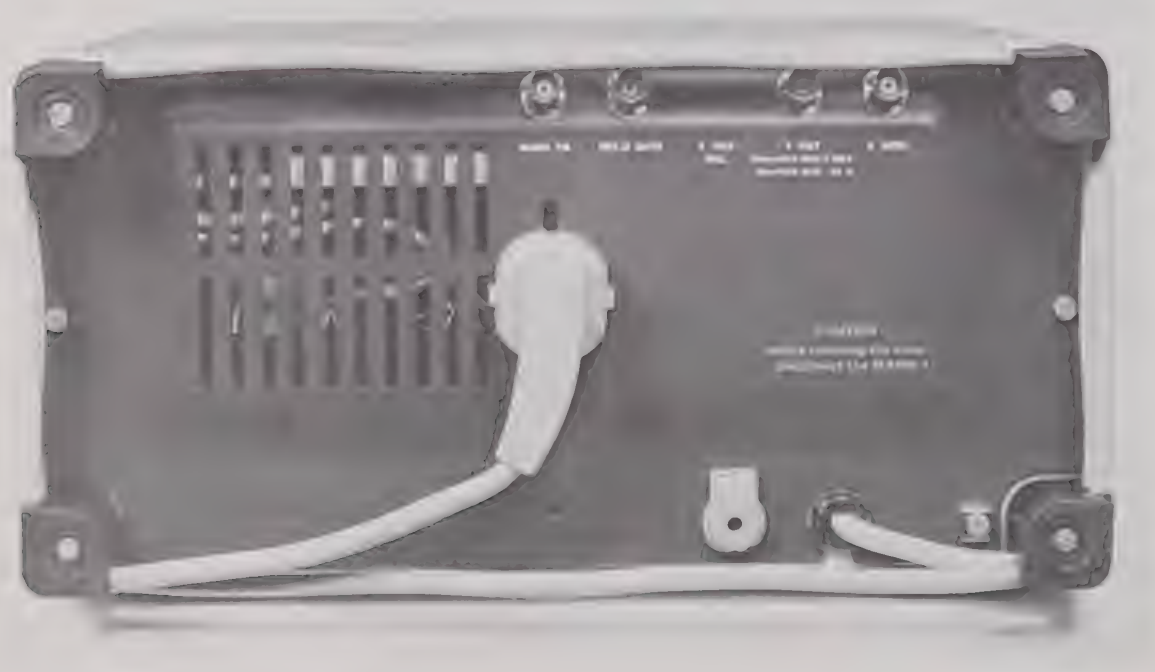


Fig. 3.23. Rear view

3.7. PARTS LIST AND DIAGRAMS
(Subject to alteration without notice)

3.7.1. Mechanical parts

ORDERING NUMBER	TYPE/DESCRIPTION
5322 455 84044	TEXT PLATE
5322 414 34147	TEN TURN KNOB
5322 276 14291	BEAM LOCATE SWITCH
5322 447 94145	ALU SIDE PROFILE
5322 447 94143	ALU FRONT PROFILE
5322 447 94144	ALU REAR PROFILE
5322 414 14011	KNOB PUSH-BUTTON
5322 414 34081	KNOB 24DIA 6 AXIS
5322 414 34119	KNOB 14DIA 4 AXIS
5322 414 74016	COVER BLUE (KNOB 14)
5322 414 34079	KNOB 18,7 DIA 6 AXIS
5322 414 34091	KNOB 10 DIA 4 AXIS
5322 414 74029	COVER BLUE (KNOB 10)
5322 414 34134	KNOB 10 DIA
5322 492 64337	SPRING (KNOB 10)
5322 414 74015	COVER GREY (KNOB 10)
5322 414 74028	SKIRT (FOR KNOB) 14
5322 535 94656	PLASTIC SPINDLE
5322 532 24398	COUPLING PART FOR SPINDLE
5322 505 14185	NUT FOR ATT.SWITCH
5322 462 34121	SUPPORT FOR PRINT
5322 256 34019	FUSE HOLDER
5322 321 14001	MAINS CABLE
5322 325 60119	CABLE CLEAT
5322 505 14186	NUT FOR POTM.UNIT
5322 535 80523	EARTH TERMINAL (BU6)
5322 505 14178	SERRATED NUT (BU6)
5322 451 34004	BEZEL
5322 480 34046	CONTRAST FILT.GREY
5322 480 34047	CONTRAST FILT.GREEN
5322 267 10004	BNC CONNECTOR
5322 267 14014	CAL TERMINAL
5322 405 94073	CAL CURRENT LOOP
5322 447 94169	PROTECTING COVER (FRONT)
5322 505 14184	PLASTIC NUT (CAL)
5322 455 84046	REAR COVER
5322 417 24024	QUICK-FASTENER
5322 447 94147	COVER (COMP) TOP
5322 447 94146	COVER (COMP) BOTTOM
5322 462 44155	RUBBER FOOT
5322 498 54045	HANDLE BAR
5322 498 54043	LEVER (RIGHT)
5322 498 54044	LEVER (LEFT)
5322 535 74401	LOCKING PIN
5322 492 54155	COMPRESSION SPRING
5322 455 84045	TEXT INSERT
5322 498 54042	INSERT PLASTIC (HANDLE)
5322 255 44088	HOLDER FOR LED
5322 405 94074	MALE CLAMPING PART
5322 405 94075	FEMAL CLAMPING PART
4822 502 11142	SCREW FOR CLAMPS
5322 462 44154	LEG COMP (REAR)
5322 320 14031	COAX 50 OHM CABLE 440 (COMPL)
5322 320 14029	COAX 50 OHM CABLE 400 (COMPL)
5322 320 14028	COAX 50 OHM CABLE 300 (COMPL)
5322 320 14027	COAX 50 OHM CABLE 500 (COMPL)
5322 480 34074	CONTRAST FILT. BLUE

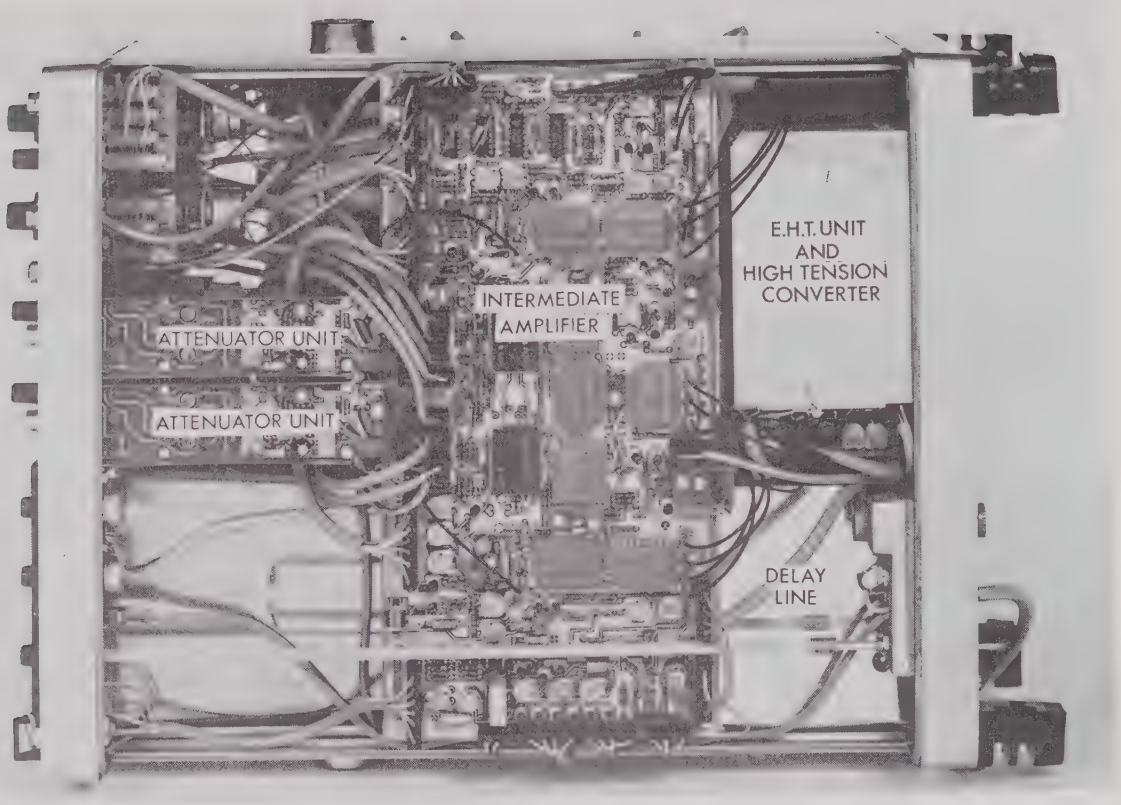


Fig. 3.24. Bottom view

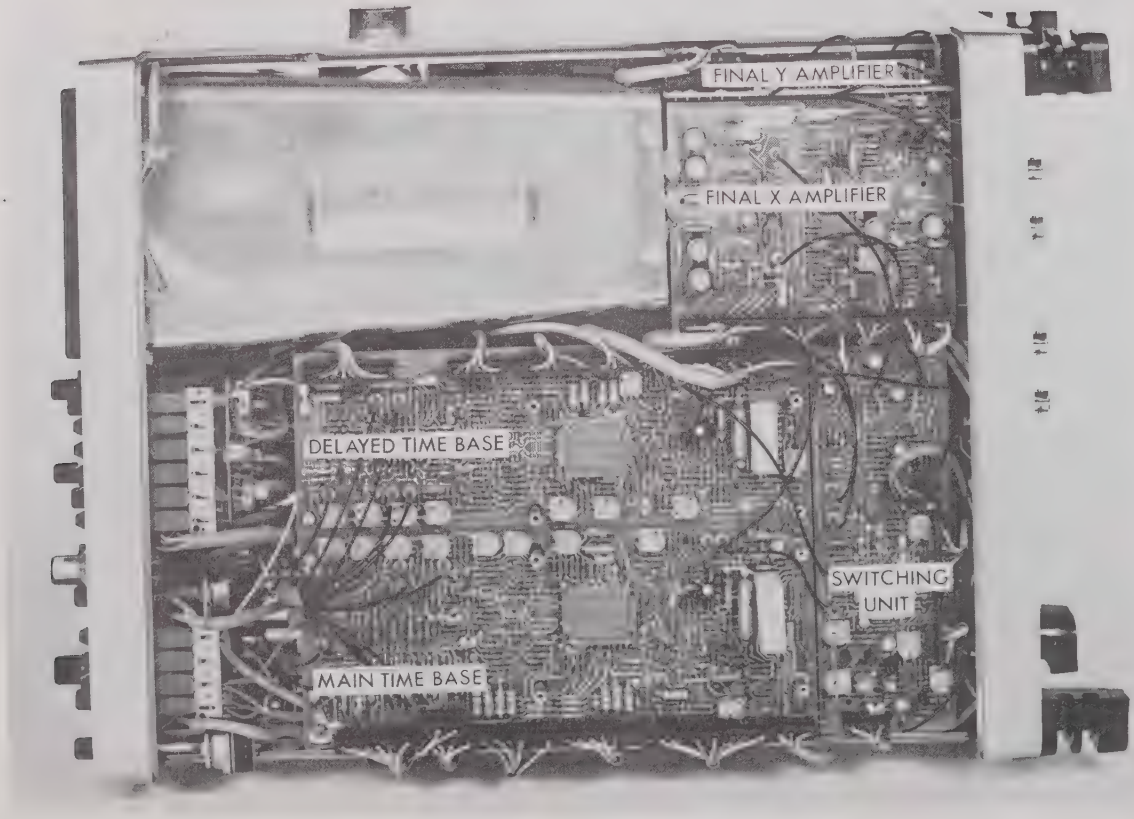


Fig. 3.25. Top view

UNITS

ITEM	ORDERING NUMBER	TYPE/DESCRIPTION
U106	5322 105 34028	MTB SWITCH COMPL. ATTENUATOR
U107	5322 105 34029	DTB SWITCH COMPL. ATTENUATOR
U2	5322 105 34031	VERT.ATTEN. COMPL. ATTENUATOR
U3	5322 218 64045	MAINS FILTER COMPL.
U4	5322 216 54144	DELAY LINE
U5	5322 216 54093	POWER SUPPLY
U6	5322 216 54094	HT CONVERTOR
U703	5322 218 64051	FOCUS UNIT
U8	5322 216 54124	MTB UNIT
U9	5322 216 54125	DTB UNIT
U10	5322 216 54126	DEFLECTION UNIT
U11	5322 216 54127	HOR.FINAL AMPL.
U12	5322 216 54128	INTERMEDIATE AMPL.
U1204	5322 310 34064	additional shift compensation circuit
U13	5322 216 54129	VERT.FINAL AMPL.
U15	5322 218 64046	EHT UNIT

ELECTRICAL PARTS

Itemnos. (e.g. C--, R--, TS--) have been divided in groups which relate to the circuit unit, according th following table.

1 --- 99	front (or rear) panel of the instrument	
100 --- 199	Y input attenuator	
200 --- 399	Intermediate Y amplifier	
400 --- 499	Final Y amplifier	
500 --- 599	Z amplifier	
600 --- 799	Trigg.	Main time-base generator
800 --- 904	Sweep circuit	
920 --- 999	Switch	
1000 --- 1199	Trigg.	Delayed time-base generator
1200 --- 1299	Sweep circuit	
1300 --- 1399	Switch	
1400 --- 1599	X Defl. selector	
1600 --- 1699	Logic and probe power (interm. Y ampl. p.c.b.)	
1700 --- 1799	Final X amplifier	
1800 --- 1899	Power supply	
1900 --- 1999	Calibration generator	
2000 --- 2099	2 kV converter	

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
CAPACITORS					
C 100	4822 122 31183	1,2PF	0,25PF	500	CERAMIC PLATE
C 101	5322 125 64009	3PF		500C	TRIMMER
C 102	5322 125 64015	4,5PF		500C	TRIMMER
C 103	5322 123 34001	30PF	10	300	MICA
C 104	4822 121 40171	22NF	10	400C	POLYESTER FOIL
C 105	4822 122 31052	8,2PF	0,25PF	100C	CERAMIC PLATE
C 106	4822 122 31052	8,2PF	0,25PF	100	CERAMIC PLATE
C 107	5322 125 64012	1,5PF		400C	TRIMMER
C 108	4822 122 31054	10PF	2	100C	CERAMIC PLATE
C 109	5322 125 64009	3PF		500C	TRIMMER
C 110	4822 122 31182	1PF	0,25PF	100C	CERAMIC PLATE
C 111	5322 125 64015	4,5PF		500C	TRIMMER
C 112	5322 123 10168	300PF	10	300	MICA
C 113	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 114	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 115	4822 121 41161	100NF	10	100C	POLYESTER FOIL
C 116	4822 122 31173	220PF	2	500	CERAMIC PLATE
C 117	4822 122 31058	15PF	2	100	CERAMIC PLATE
C 118	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 119	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 120	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 121	5322 125 50049	10PF		300C	TRIMMER
C 122	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 123	4822 122 30027	1NF	-20+80	40	CERAMIC PLATE
C 124	4822 122 30103	10NF	-20+80	40C	CERAMIC PLATE
C 125	4822 122 30103	10NF	-20+80	40C	CERAMIC PLATE
C 126	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 127	5322 125 50049	10PF		300C	TRIMMER
C 128	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 129	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 130	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 200	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 201	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 202	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 203	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 204	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 206	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 207	4822 122 30091	390PF	10	100	CERAMIC PLATE
C 209	4822 121 40411	33NF	10	250C	POLYESTER FOIL
C 210	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 217	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 218	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 219	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 220	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 221	5322 125 50051	18PF		300C	TRIMMER
C 222	4822 122 30098	3,9NF	10	100	CERAMIC PLATE
C 224	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 225	4822 122 31164	1,8NF	10	100	CERAMIC PLATE
C 226	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 227	4822 122 31173	220PF	10	100	CERAMIC PLATE
C 228	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 229	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 231	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 232	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 233	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 234	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 236	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 237	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 238	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 244	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 245	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 246	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 247	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
C 248	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 249	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 250	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 251	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 252	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 253	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 254	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 255	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 257	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 258	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 262	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 264	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 266	4822 122 31116	2,2NF	10	100	CERAMIC PLATE
C 300	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 301	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 302	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 303	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 304	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 306	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 307	4822 122 30091	390PF	10	100	CERAMIC PLATE
C 309	4822 121 40411	33NF	10	250C	POLYESTER FOIL
C 310	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 316	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 317	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 318	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 319	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 320	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 324	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 325	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 326	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 328	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 329	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 331	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 332	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 336	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 337	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 351	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 352	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 353	4822 124 20452	33UF	-10+50	6,3	ELECTROLYTIC
C 354	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 356	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 361	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 362	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 400	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 401	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 402	4822 122 31164	1,8NF	10	100	CERAMIC PLATE
C 406	5322 121 44025	33NF	10	250C	POLYESTER FOIL
C 407	5322 125 50051	18PF		300C	TRIMMER
C 408	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 409	4822 122 31085	150PF	2	100	CERAMIC PLATE
C 410	4822 122 31038	2,7PF	0,25PF	100	CERAMIC PLATE
C 411	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 412	4822 122 31085	150PF	2	100	CERAMIC PLATE
C 413	5322 121 44138	47NF	10	250C	POLYESTER FOIL
C 414	5322 121 44138	47NF	10	250C	POLYESTER FOIL
C 416	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 417	4822 122 31085	150PF	2	100	CERAMIC PLATE
C 419	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 421	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 422	4822 122 31164	1,8NF	10	100	CERAMIC PLATE
C 500	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 501	4822 122 31192	6,8PF	0,25PF	500	CERAMIC PLATE
C 502	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 503	4822 122 31116	2,2NF	10	500	CERAMIC PLATE
C 504	4822 121 41161	100NF	10	250C	POLYESTER FOIL

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
C 505	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 506	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 507	4822 122 30034	47PF	2	100	CERAMIC PLATE
C 508	4822 121 41161	100NF	10	250C	POLYESTER FOIL
C 509	5322 125 50048	3,5PF	10	300C	TRIMMER
C 510	4822 122 31197	15PF	2	500	CERAMIC PLATE
C 511	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 513	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 514	4822 122 30098	3,9NF	10	100	CERAMIC PLATE
C 515	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 516	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 517	4822 122 30098	33NF	10	400C	CERAMIC PLATE
C 518	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 519	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 520	4822 122 31197	15PF	2	500	CERAMIC PLATE
C 521	5322 122 50044	1NF	-20+50	3K	CERAMIC DISK
C 522	5322 122 50001	4,7NF	-20+50	3K	CERAMIC DISK
C 523	4822 121 40411	33NF	10	250C	POLYESTER FOIL
C 524	4822 122 31211	100PF	10	500	CERAMIC PLATE
C 525	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 526	4822 121 41161	100NF	10	250C	POLYESTER FOIL
C 527	4822 121 41161	100NF	10	250C	POLYESTER FOIL
C 528	4822 121 40366	15NF	10	1000C	POLYESTER FOIL
C 529	4822 121 40195	33NF	10	1600C	POLYESTER FOIL
C 530	5322 122 50001	4,7NF	-20+50	3K	CERAMIC DISK
C 531	4822 121 40429				POLYESTER FOIL
C 532	4822 122 31174	2,7NF	10	500	CERAMIC PLATE
C 533	4822 122 31174	2,7NF	10	500	CERAMIC PLATE
C 534	5322 122 50044	1NF	-20+50	3K	CERAMIC DISK
C 535	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 536	4822 122 31174	2,7NF	10	500	CERAMIC PLATE
C 537	4822 121 40411	33NF	10	250C	POLYESTER FOIL
C 538	4822 121 40411	33NF	10	250C	POLYESTER FOIL
C 539	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 540	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 541	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 542	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 543	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 544	4822 122 31061	18PF	2	100	CERAMIC PLATE
C 545	5322 125 50048	3,5PF		300C	TRIMMER
C 546	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 601	4822 120 11058	15PF	5	500	CERAMIC
C 602	4822 122 31201	27PF	2	500	CERAMIC PLATE
C 603	4822 122 31172	180PF	2	500	CERAMIC PLATE
C 604	4822 122 31052	8,2PF	0,25PF	100	CERAMIC PLATE
C 605	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 606	4822 122 31052	8,2PF	0,25PF	100	CERAMIC PLATE
C 607	4822 122 31178	680PF	10	500	CERAMIC PLATE
C 608	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 610	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 611	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 612	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 613	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 614	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 615	4822 122 31052	8,2PF	0,25PF	100	CERAMIC PLATE
C 616	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 617	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 618	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 619	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 620	4822 122 31058	15PF	2	100	CERAMIC PLATE
C 621	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 622	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 623	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 624	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 625	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
C 626	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 627	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 628	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 629	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 630	4822 122 31069	39PF	2	100	CERAMIC PLATE
C 631	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 633	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 634	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 635	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 636	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 637	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 638	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 639	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 642	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 643	5322 124 10014	4,7UF		35	ELECTROLYTIC TANTALUM
C 644	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 645	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 646	4822 124 20459	22UF	-10+50	10	ELECTROLYTIC
C 647	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 648	4822 124 20459	22UF	-10+50	10	ELECTROLYTIC
C 649	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 652	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 653	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 654	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 656	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 657	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 800	4822 124 20459	22UF	-10+50	10	ELECTROLYTIC
C 801	4822 122 31058	15PF	2	100	CERAMIC PLATE
C 802	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 803	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 804	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 805	5322 121 54062	4,3NF	1	63C	POLYSTYRENE FOIL
C 806	4822 121 50549				POLYSTYRENE FOIL
C 807	5322 121 40224				POLYESTER FOIL
C 808	5322 121 54108				POLYSTYRENE FOIL
C 809	5322 124 14057	100UF		10	ELECTROLYTIC TANTALUM
C 810	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 811	4822 121 40427				POLYESTER FOIL
C 812	4822 122 31172	180PF	10	100	CERAMIC PLATE
C 813	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 814	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 815	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 816	4822 122 31221	1,5NF	10	100	CERAMIC PLATE
C 818	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 819	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 820	4822 124 20459	22UF	-10+50	10	ELECTROLYTIC
C 821	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 822	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 823	4822 124 20459	22UF	-10+50	10	ELECTROLYTIC
C 824	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 825	4822 122 31219	680NF	10	100C	CERAMIC PLATE
C 827	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1001	4822 120 11049	6,8PF	0,5PF	500	CERAMIC
C 1002	4822 120 11052	8,2PF	0,5PF	500	CERAMIC
C 1004	4822 122 31052	8,2PF	0,25PF	100	CERAMIC PLATE
C 1005	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1006	4822 122 31052	8,2PF	0,25PF	100	CERAMIC PLATE
C 1007	4822 122 30091	390PF	2	100	CERAMIC PLATE
C 1008	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1010	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 1011	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 1013	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1014	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1017	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 1018	4822 122 31054	10PF	2	100	CERAMIC PLATE

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
C 1019	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 1020	4822 122 31058	15PF	2	100	CERAMIC PLATE
C 1021	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1022	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1023	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1024	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1026	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1027	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1028	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1029	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1030	4822 122 31069	39PF	2	100	CERAMIC PLATE
C 1031	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C1032	4822 122 31072	47PF	2	100	CERAMIC PLATE
C 1033	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 1034	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 1035	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1036	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1037	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1038	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1039	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1040	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1041	4822 122 30043	22NF	-20+80	40C	CERAMIC PLATE
C 1044	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 1045	4822 122 30043	22NF	-20+80	40C	CERAMIC PLATE
C 1046	4822 124 20459	22UF	-10+50	10	ELECTROLYTIC
C 1047	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 1048	4822 124 20459	22UF	-10+50	10	ELECTROLYTIC
C 1049	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1052	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1053	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1054	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1056	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1057	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1200	5322 121 54108	47NF	1	63C	POLYSTYRENE FOIL
C 1201	4822 122 31058	15PF	2	100	CERAMIC PLATE
C 1202	4822 121 50549	442PF	1	250C	POLYSTYRENE FOIL
C 1203	5322 121 40224	4,7MF	10	100C	POLYESTER FOIL
C 1204	5322 121 54062	4,3NF	1	63C	POLYSTYRENE FOIL
C 1205	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1206	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1207	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1208	4822 122 31221	1,5NF	10	100	CERAMIC PLATE
C 1209	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 1210	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1211	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 1212	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 1213	4822 124 20459	22UF	-10+50	10	ELECTROLYTIC
C 1214	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 1216	4822 124 20459	22UF	-10+50	10	ELECTROLYTIC
C 1217	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1218	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1219	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1221	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1301	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1404	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1405	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1407	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1408	5322 125 50051	18PF		300C	TRIMMER
C 1409	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1413	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1414	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1416	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1417	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1418	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1419	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1421	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
C 1422	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1423	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1424	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1426	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1600	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1601	4822 122 30135	820PF	10	100	CERAMIC PLATE
C 1602	4822 122 31067	33PF	2	100	CERAMIC PLATE
C 1603	4822 122 31085	150PF	2	100	CERAMIC PLATE
C 1604	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1605	4822 122 30027	1NF	10	100	CERAMIC PLATE
C 1606	4822 122 31173	220PF	10	100	CERAMIC PLATE
C 1607	4822 122 30027	1NF	10	100	CERAMIC PLATE
C 1608	4822 122 31085	150PF	2	100	CERAMIC PLATE
C 1609	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1610	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1611	4822 124 20589	220UF	-10+50	10	ELECTROLYTIC
C 1612	4822 124 20589	220UF	-10+50	10	ELECTROLYTIC
C 1613	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 1614	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1615	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C1616	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1621	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1622	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1623	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 1624	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1625	4822 121 41161	100NF	10	100C	POLYESTER FOIL
C 1626	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1627	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1629	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1632	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1701	4822 122 31116	2,2NF	10	500	CERAMIC PLATE
C 1702	5322 122 34039	0,56PF	0,25PF	100	CERAMIC PLATE
C 1703	5322 125 54026	3PF		400C	TRIMMER
C 1704	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1706	4822 121 41161	100NF	10	250C	POLYESTER FOIL
C 1707	5322 125 54026	3PF	10	400C	TRIMMER
C 1708	5322 122 34039	0,56PF	0,25PF	100	CERAMIC PLATE
C 1709	4822 122 31116	2,2NF	10	500	CERAMIC PLATE
C 1711	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1712	4822 121 41161	100NF	10	250C	POLYESTER FOIL
C 1713	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1714	4822 121 40239	47NF	10	250C	POLYESTER FOIL
C 1716	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1717	4822 121 40239	47NF	10	250C	POLYESTER FOIL
C 1801	5322 121 44142	220NF	10	250	POLYESTER FOIL
C 1802	5322 122 44009	2,2NF	20	250	CERAMIC DISK
C 1803	5322 122 44009	2,2NF	20	250	CERAMIC DISK
C 1804	5322 121 44142	220NF	10	250	POLYESTER FOIL
C 1805	4822 121 40427	220NF	10	100C	POLYESTER FOIL
C 1806	4822 124 40066	2X50MF		400C	ELECTROLYTIC
C 1807	4822 124 40066	2X50MF		400C	ELECTROLYTIC
C 1808	4822 124 20462	100UF	-10+50	10	ELECTROLYTIC
C 1809	5322 124 24153	220UF		100	ELECTROLYTIC
C 1810	4822 124 20581	220UF	-10+50	4	ELECTROLYTIC
C 1811	4822 121 40239	47NF	10	100C	POLYESTER FOIL
C 1812	4822 124 20581	220UF	-10+50	4	ELECTROLYTIC
C 1813	4822 122 31173	220PF	10	100	CERAMIC PLATE
C 1814	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 1815	4822 121 40208	1MF	10	250C	POLYESTER FOIL
C 1816	4822 121 40104	150NF	10	250C	POLYESTER FOIL
C 1817	4822 121 40452	1,5MF	10	100C	POLYESTER FOIL
C 1818	4822 124 20483	6,8UF	-10+50	40	ELECTROLYTIC
C 1819	4822 121 41169	220NF	10	100C	POLYESTER FOIL
C 1820	4822 122 31175	1NF	10	100	CERAMIC PLATE
C 1821	4822 121 40407	22NF	10	250C	POLYESTER FOIL
C 1822	4822 121 41169	220NF	10	250C	POLYESTER FOIL

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
C 1823	4822 121 41161	100NF	10	250C	POLYESTER FOIL
C 1824	4822 124 20465	330UF	-10+50	10	ELECTROLYTIC
C 1825	5322 122 54006	3,3NF	-20+50	3K	CERAMIC DISK
C 1826	4822 121 41161	100NF	10	250C	POLYESTER FOIL
C 1827	4822 121 41161	100NF	10	250C	POLYESTER FOIL
C 1828	4822 121 41161	100NF	10	250C	POLYESTER FOIL
C 1829	4822 121 41161	100NF	10	250C	POLYESTER FOIL
C 1830	4822 121 40104	150NF	10	250C	POLYESTER FOIL
C 1831	4822 124 20497	15UF	-10+50	63	ELECTROLYTIC
C 1832	4822 124 20497	15UF	-10+50	63	ELECTROLYTIC
C 1833	4822 124 20488	100UF	-10+50	40	ELECTROLYTIC
C 1834	4822 124 20485	33UF	-10+50	40	ELECTROLYTIC
C 1835	4822 121 40239	47NF	10	250C	POLYESTER FOIL
C 1836	4822 124 20488	100UF	-10+50	40	ELECTROLYTIC
C 1837	4822 124 20485	33UF	-10+50	40	ELECTROLYTIC
C 1838	4822 124 20469	68UF	-10+50	16	ELECTROLYTIC
C 1839	4822 124 20469	68UF	-10+50	16	ELECTROLYTIC
C 1840	4822 121 41161	100NF	10	250C	POLYESTER FOIL
C 1841	4822 124 20469	68UF	-10+50	16	ELECTROLYTIC
C 1842	4822 124 20469	68UF	-10+50	16	ELECTROLYTIC
C 1843	4822 124 20454	150UF	-10+50	6,3	ELECTROLYTIC
C 1844	4822 124 20454	150UF	-10+50	6,3	ELECTROLYTIC
C 1845	4822 121 40411				POLYESTER FOIL
C 1846	4822 124 20454	150UF	-10+50	6,3	ELECTROLYTIC
C 1847	4822 124 20454	150UF	-10+50	6,3	ELECTROLYTIC
C 1849	4822 122 31177	470PF	10	500	CERAMIC PLATE
C 1851	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 1861	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1862	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1863	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1864	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1866	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1867	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1868	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1901	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 1902	5322 121 40233				POLYESTER FOIL
C 1903	4822 121 50611	20NF	1	63C	POLYSTYRENE FOIL
C 1904	4822 124 20453	68UF	-10+50	6,3	ELECTROLYTIC
C 2000	4822 124 20497	15UF	-10+50	63	ELECTROLYTIC
C 2001	4822 124 20501	47UF	-10+50	63	ELECTROLYTIC
C 2002	5322 122 30134	10NF	-20+50	3K	CERAMIC PLATE
C 2003	4822 121 40427	220NF	10	100C	POLYESTER FOIL
C 2004	4822 121 40411	33NF	10	250C	POLYESTER FOIL
C 2006	4822 122 31175	22NF	-20+100	40C	CERAMIC PLATE
C 2007	4822 121 40443	680NF	10	100C	POLYESTER FOIL
C 2018	5322 122 54007	220PF	20	5K	CERAMIC DISK
C 2019	5322 122 54007	220PF	20	5K	CERAMIC DISK
C 2021	5322 122 54007	220PF	20	5K	CERAMIC DISK
C 2022	5322 122 54007	220PF	20	5K	CERAMIC DISK
C 2023	5322 122 54007	220PF	20	5K	CERAMIC DISK
C 2024	5322 122 54007	220PF	20	5K	CERAMIC DISK
C 2026	5322 122 54007	220PF	20	5K	CERAMIC DISK
C 2027	5322 122 54007	220PF	20	5K	CERAMIC DISK
C 2028	5322 122 54007	220PF	20	5K	CERAMIC DISK

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
RESISTORS					
1	5322 103 64016	5K	5	2W	WIRE-WOUND POTENTIOMETER
2	5322 101 44015	50K	20		CARBON POTM LIN + SWITCH
3	5322 101 24056	1K	20	0,1W	CARBON POTM LIN
4	5322 101 24068	100	20	0,5W	CARBON POTM LIN
5	5322 101 24105	1K	20	0,5W	CARBON POTM LIN
6	5322 101 24106	100	20		CARBON POTM LIN
7	5322 101 24056	1K	20	0,1W	CARBON POTM LIN
8	5322 101 64011	100K	20	0,1W	CARBON POTM LIN + SWITCH
9	5322 101 24107	47K	20	0,1W	CARBON POTM LIN
10	5322 101 64011	100K	20	0,1W	CARBON POTM LIN + SWITCH
11	5322 101 24047	22K	20	0,1W	CARBON POTM LIN
13	5322 101 40041	4,7K	20	0,25W	CARBON POTM LIN + SWITCH
14	5322 101 40041	4,7K	20	0,25W	CARBON POTM LIN + SWITCH
15	5322 101 24099	10K	20	0,1W	CARBON POTM LIN
16	5322 101 24065	4,7K	20	0,1W	CARBON POTM LIN
19	5322 101 24055	25K	20		CARBON POTM LIN
20	4822 101 20417	22K	20	0,1W	CARBON POTM LIN
21	4822 101 20417	22K	20	0,1W	CARBON POTM LIN
22	5322 101 64009	10K	20		CARBON POTM LIN + SWITCH
23	5322 101 20267	470	20	0,1W	CARBON POTM LIN
100	5322 116 64054	68	5	0,125W	METAL OXIDE
101	5322 116 64045	10	5	0,125	METAL OXIDE
102	5322 116 55021	900K	0,5		METAL FILM
103	5322 116 64048	56	5	0,125	METAL OXIDE
104	5322 116 54213	111K	0,25	MCR24	METAL FILM
106	5322 116 64046	51	5	0,125W	METAL OXIDE
107	5322 116 64051	15	0,5	0,125	METAL OXIDE
109	5322 116 64047	560	5	0,125W	METAL OXIDE
110	5322 116 64048	56	5	0,125W	METAL OXIDE
111	5322 116 64047	560	5	0,125W	METAL OXIDE
112	5322 116 64045	10	5	0,125	METAL OXIDE
113	5322 116 55022	992K	0,25		METAL FILM
114	5322 116 64048	56	5	0,125	METAL OXIDE
115	5322 116 64048	56	5	0,125W	METAL OXIDE
116	5322 116 54211	10K	0,25	MR24CR	METAL FILM
117	5322 116 64051	15	5	0,125W	METAL OXIDE
118	5322 116 64051	15	5	0,125W	METAL OXIDE
119	5322 111 30376	100M	5	0,125W	CARBON
120	5322 116 54549	100	5	0,125	METAL FILM
121	5322 116 54589	3,83K	1	MR25	METAL FILM
122	5322 116 54012	6,81K	1	MR25	METAL FILM
123	5322 116 54519	402	1	MR25	METAL FILM
124	5322 116 54208	249K	1	MR25R	METAL FILM
126	5322 116 54774	750K	1	MR30R	METAL FILM
127	5322 116 54038	221K	1	MR25	METAL FILM
128	4822 110 42214	10M	5	VR37	CARBON
129	5322 100 10143	1K	20	0,75W	TRIMMING POTM
131	5322 116 54208	249K	1	MR25R	METAL FILM
132	5322 100 10141	10K	20	0,75W	TRIMMING POTM
134	4822 110 42227	33M	5	VR37	CARBON
136	5322 116 54007	475	1	MR25	METAL FILM
137	5322 116 54549	1K	1	MR25	METAL FILM
138	5322 116 64052	39	5	0,125W	METAL OXIDE
148	5322 116 50592	442	1	MR25	METAL FILM
149	5322 116 50592	442	1	MR25	METAL FILM
151	5322 116 54541	825	1	MR25	METAL FILM
200	5322 116 50767	2,15K	1	MR25	METAL FILM
201	5322 101 14069	22K	20	0,5W	TRIMMING POTM
202	5322 116 54608	7,5K	1	MR25	METAL FILM
203	5322 116 50586	1,54K	1	MR25	METAL FILM
204	5322 101 14047	470	20	0,5W	TRIMMING POTM
205	4822 111 30324	100	5	CR16	CARBON
206	5322 116 54571	1,96K	1	MR25	METAL FILM
207	5322 116 50524	3,01K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 208	5322 116 50635	1,47K	1	MR25	METAL FILM
R 209	5322 116 54532	649	1	MR25	METAL FILM
R 210	4822 111 30324	100	5	CR16	CARBON
R 211	5322 101 14047	470	20	0,5W	TRIMMING POTM
R 212	5322 116 54499	249	1	MR25	METAL FILM
R 213	4822 111 30269	1K	5	CR16	CARBON
R 214	5322 111 30365	51	5	CR16	CARBON
R 215	5322 116 54549	1K	1	MR25	METAL FILM
R 216	5322 116 54619	10K	1	MR25	METAL FILM
R 217	5322 111 30396	22	5	CR16	CARBON
R 218	5322 111 44168	110	5	CR16	CARBON
R 219	5322 116 54568	1,82K	1	MR25	METAL FILM
R 220	5322 100 10139	4,7K	20	0,75W	TRIMMING POTM
R 221	5322 100 10143	1K	20	0,75W	TRIMMING POTM
R 222	5322 100 10144	2,2K	20	0,75W	TRIMMING POTM
R 223	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 224	5322 116 54482	133	1	MR25	METAL FILM
R 225	5322 116 54012	6,81K	1	MR25	METAL FILM
R 226	5322 116 54531	634	1	MR25	METAL FILM
R 227	5322 116 54585	3,48K	1	MR25	METAL FILM
R 228	5322 116 54549	1K	1	MR25	METAL FILM
R 229	5322 116 54615	9,09K	1	MR25	METAL FILM
R 230	4822 116 30018	1,3K	20	1W	NTC
R 231	5322 116 50664	2,05K	1	MR25	METAL FILM
R 232	5322 111 30396	22	5	CR16	CARBON
R 233	5322 111 30365	51	5	CR16	CARBON
R 234	5322 100 10144	2,2K	20	0,75W	TRIMMING POTM
R 235	4822 111 30347	10	5	CR16	CARBON
R 236	5322 111 30365	51	5	CR16	CARBON
R 237	5322 111 30396	22	5	CR16	CARBON
R 238	4822 111 30272	680	5	CR16	CARBON
R 239	5322 116 50664	2,05K	1	MR25	METAL FILM
R 240	4822 111 30347	10	5	CR16	CARBON
R 241	5322 116 54469	100	1	MR25	METAL FILM
R 242	5322 116 54469	100	1	MR25	METAL FILM
R 243	5322 116 54472	105	1	MR25	METAL FILM
R 244	5322 116 54469	100	1	MR25	METAL FILM
R 245	4822 116 30122	330	10	0,5W	NTC
R 246	5322 116 50414	2,87K	1	MR25	METAL FILM
R 247	5322 116 50669	205	1	MR25	METAL FILM
R 248	5322 116 50414	2,87K	1	MR25	METAL FILM
R 249	5322 116 54585	3,48K	1	MR25	METAL FILM
R 250	5322 116 54469	100	1	MR25	METAL FILM
R 251	5322 116 54549	1K	1	MR25	METAL FILM
R 252	5322 116 54589	3,83K	1	MR25	METAL FILM
R 253	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 254	5322 116 54549	1K	1	MR25	METAL FILM
R 255	5322 111 44143	15K	5	CR16R	CARBON
R 256	5322 116 54571	1,96K	1	MR25	METAL FILM
R 257	5322 116 54571	1,96K	1	MR25	METAL FILM
R 258	5322 116 54549	1K	1	MR25	METAL FILM
R 259	5322 111 44132	30	5	CR16	CARBON
R 260	4822 110 60179	510K	5	CR25	CARBON
R 261	5322 111 44132	30	5	CR16	CARBON
R 262	5322 116 54513	332	1	MR25	METAL FILM
R 263	5322 116 54545	909	1	MR25	METAL FILM
R 264	5322 116 54545	909	1	MR25	METAL FILM
R 265	5322 116 54455	68,1	1	MR25	METAL FILM
R 266	4822 111 30324	100	5	CR16	CARBON
R 268	4822 111 30324	100	5	CR16	CARBON
R 269	5322 116 54696	100K	1	MR25	METAL FILM
R 271	5322 116 54549	1K	1	MR25	METAL FILM
R 272	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 273	5322 116 54482	133	1	MR25	METAL FILM
R 274	5322 116 54589	3,83K	1	MR25	METAL FILM
R 275	5322 116 54612	8,45K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 276	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 279	5322 116 54482	133	1	MR25	METAL FILM
R 280	5322 116 50458	7,87K	1	MR25	METAL FILM
R 281	5322 116 54554	1,1K	1	MR25	METAL FILM
R 282	5322 116 50592	442	1	MR25	METAL FILM
R 283	5322 116 50583	5,9K	1	MR25	METAL FILM
R 284	5322 116 54608	7,5K	1	MR25	METAL FILM
R 286	5322 116 50728	1,87K	1	MR25	METAL FILM
R 287	5322 116 54554	1,1K	1	MR25	METAL FILM
R 290	5322 111 34089	1,1K	5	CR16	CARBON
R 291	4822 111 30328	330	5	CR16	CARBON
R 292	5322 100 10144	2,2K	20	0,75W	TRIMMING POTM
R 293	4822 111 30328	330	5	CR16	CARBON
R 294	5322 116 50664	2,05K	1	MR25	METAL FILM
R 296	5322 116 54562	5,9K	1	MR25R	METAL FILM
R 297	5322 116 54562	5,9K	1	MR25R	METAL FILM
R 298	5322 111 44132	30	5	CR16	CARBON
R 299	5322 111 44132	30	5	CR16	CARBON
R 301	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 302	5322 116 54608	7,5K	1	MR25	METAL FILM
R 303	5322 116 50586	1,54K	1	MR25	METAL FILM
R 304	5322 101 14047	470	20	0,5W	TRIMMING POTM
R 306	5322 116 54571	1,96K	1	MR25	METAL FILM
R 307	5322 116 50524	3,01K	1	MR25	METAL FILM
R 308	5322 116 50635	1,47K	1	MR25	METAL FILM
R 309	5322 116 54532	649	1	MR25	METAL FILM
R 311	5322 101 14047	470	20	0,5W	TRIMMING POTM
R 312	5322 116 54499	249	1	MR25	METAL FILM
R 313	4822 111 30269	1K	5	CR16	CARBON
R 314	5322 111 30365	51	5	CR16	CARBON
R 316	5322 116 54619	10K	1	MR25	METAL FILM
R 317	5322 111 30396	22	5	CR16	CARBON
R 318	5322 111 44168	110	5	CR16	CARBON
R 319	5322 116 54568	1,82K	1	MR25	METAL FILM
R 321	5322 100 10143	1K	20	0,75W	TRIMMING POTM
R 322	5322 100 10144	2,2K	20	0,75W	TRIMMING POTM
R 323	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 324	5322 116 54482	133	1	MR25	METAL FILM
R 325	5322 116 54012	6,81K	1	MR25	METAL FILM
R 326	5322 116 54531	634	1	MR25	METAL FILM
R 327	5322 116 54585	3,48K	1	MR25	METAL FILM
R 328	5322 116 54549	1K	1	MR25	METAL FILM
R 329	5322 116 54615	9,09K	1	MR25	METAL FILM
R 330	4822 116 30018	1,3K	20	1W	NTC
R 331	5322 116 50664	2,05K	1	MR25	METAL FILM
R 332	5322 111 30396	22	5	CR16	CARBON
R 333	5322 111 30365	51	5	CR16	CARBON
R 335	4822 111 30347	10	5	CR16	CARBON
R 336	5322 111 30365	51	5	CR16	CARBON
R 337	5322 111 30396	22	5	CR16	CARBON
R 338	4822 111 30272	680	5	CR16	CARBON
R 339	5322 116 50664	2,05K	1	MR25	METAL FILM
R 340	4822 111 30347	10	5	CR16	CARBON
R 341	5322 116 54469	100	1	MR25	METAL FILM
R 342	5322 116 54469	100	1	MR25	METAL FILM
R 343	5322 116 54472	105	1	MR25	METAL FILM
R 344	5322 116 54469	100	1	MR25	METAL FILM
R 345	4822 116 30122	330	10	0,5W	NTC
R 346	5322 116 50414	2,87K	1	MR25	METAL FILM
R 347	5322 116 50669	205	1	MR25	METAL FILM
R 348	5322 116 50414	2,87K	1	MR25	METAL FILM
R 349	5322 116 54585	3,48K	1	MR25	METAL FILM
R 350	5322 116 54469	100	1	MR25	METAL FILM
R 351	5322 116 54549	1K	1	MR25	METAL FILM
R 352	5322 116 54589	3,83K	1	MR25	METAL FILM
R 353	5322 101 14069	22K	20	0,5W	TRIMMING POTM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 354	5322 116 50415	1,15K	1	MR25	METAL FILM
R 356	5322 116 50731	10,5K	1	MR25	METAL FILM
R 357	5322 116 50415	1,15K	1	MR25	METAL FILM
R 358	5322 116 50731	10,5K	1	MR25	METAL FILM
R 359	5322 116 54005	3,32K	1	MR25	METAL FILM
R 360	4822 110 60179	510K	5	CR25	CARBON
R 361	5322 116 54005	3,32K	1	MR25	METAL FILM
R 362	5322 116 50581	2,49K	1	MR25	METAL FILM
R 363	5322 116 54549	1K	1	MR25	METAL FILM
R 372	5322 116 54567	1,69K	1	MR25	METAL FILM
R 373	5322 116 54565	1,62K	1	MR25	METAL FILM
R 374	5322 116 50766	147	1	MR25	METAL FILM
R 376	5322 116 54565	1,62K	1	MR25	METAL FILM
R 377	5322 116 50766	147	1	MR25	METAL FILM
R 378	5322 116 50452	10	1	MR25	METAL FILM
R 382	5322 116 54567	1,69K	1	MR25	METAL FILM
R 383	5322 116 54565	1,62K	1	MR25	METAL FILM
R 384	5322 116 50766	147	1	MR25	METAL FILM
R 386	5322 116 54565	1,62K	1	MR25	METAL FILM
R 387	5322 116 50766	147	1	MR25	METAL FILM
R 388	5322 116 50452	10	1	MR25	METAL FILM
R 391	5322 116 50628	1,37K	1	MR25	METAL FILM
R 392	5322 116 54549	1K	1	MR25	METAL FILM
R 401	5322 116 54451	61,9	1	MR25	METAL FILM
R 402	5322 116 54451	61,9	1	MR25	METAL FILM
R 403	5322 116 50484	4,64K	1	MR25	METAL FILM
R 404	5322 100 10144	2,2K	20	0,75W	TRIMMING POTM
R 405	5322 100 10139	4,7K	20	0,75W	TRIMMING POTM
R 406	5322 100 10143	1K	20	0,75W	TRIMMING POTM
R 407	5322 116 50479	15,4K	1	MR25	METAL FILM
R 408	5322 100 10138	100	20	0,75W	TRIMMING POTM
R 409	5322 101 14056	47K	20	0,75W	TRIMMING POTM
R 410	5322 101 14056	47K	20	0,75W	TRIMMING POTM
R 411	5322 116 54575	2,32K	1	MR25	METAL FILM
R 412	5322 116 54696	100K	1	MR25	METAL FILM
R 413	5322 116 54696	100K	1	MR25	METAL FILM
R 418	5322 116 64005	200	5	5E	METAL OXIDE
R 419	5322 116 54466	90,9	1	MR25	METAL FILM
R 421	5322 116 54466	90,9	1	MR25	METAL FILM
R 422	5322 116 50592	442	1	MR25	METAL FILM
R 423	5322 101 14093	50	20	0,5W	TRIMMING POTM
R 424	5322 116 54466	90,9	1	MR25	METAL FILM
R 426	5322 116 54466	90,9	1	MR25	METAL FILM
R 427	5322 116 64005	200	5	5E	METAL OXIDE
R 429	5322 116 50555	1,27K	1	MR25	METAL FILM
R 430	5322 116 54603	6,49K	1	MR25	METAL FILM
R 432	5322 100 10141	10K	20	0,75W	TRIMMING POTM
R 433	5322 116 54536	750	1	MR25	METAL FILM
R 434	5322 116 54536	750	1	MR25	METAL FILM
R 436	5322 116 54565	1,62K	1	MR25	METAL FILM
R 482	5322 116 50592	442	1	MR25	METAL FILM
R 500	5322 116 54513	332	1	MR25	METAL FILM
R 501	5322 116 54759	464K	1	MR30	METAL FILM
R 502	5322 116 50664	2,05K	1	MR25	METAL FILM
R 503	5322 116 54758	536K	1	MR30	METAL FILM
R 504	5322 116 54683	68,1K	1	MR25	METAL FILM
R 505	4822 110 63036	2,2	5	CR25	CARBON
R 506	5322 116 54442	51,1	1	MR25	METAL FILM
R 507	5322 116 54442	51,1	1	MR25	METAL FILM
R 508	5322 116 50729	4,22K	1	MR25	METAL FILM
R 509	5322 116 50557	46,4K	1	MR25	METAL FILM
R 510	4822 110 63036	2,2	5	CR25	CARBON
R 511	5322 116 54743	301K	1	MR25	METAL FILM
R 512	5322 116 54623	11K	1	MR25	METAL FILM
R 513	5322 116 50635	1,47K	1	MR25	METAL FILM
R 514	5322 116 54005	3,32K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 516	5322 116 54005	3,32K	1	MR25	METAL FILM
R 517	5322 116 50664	2,05K	1	MR25	METAL FILM
R 518	5322 116 54661	34,8K	1	MR25	METAL FILM
R 519	5322 116 54536	750	1	MR25	METAL FILM
R 520	4822 110 63036	2,2	5	CR25	CARBON
R 521	5322 116 54689	82,5K	1	MR25	METAL FILM
R 522	5322 116 50492	46,4	1	MR25	METAL FILM
R 523	5322 116 54462	82,5	1	MR25	METAL FILM
R 524	5322 116 50524	3,01K	1	MR25	METAL FILM
R 525	5322 116 50536	464	1	MR25	METAL FILM
R 526	5322 116 50492	46,4	1	MR25	METAL FILM
R 528	5322 116 50492	46,4	1	MR25	METAL FILM
R 529	5322 116 50601	464	1	MR30	METAL FILM
R 531	5322 116 54635	16,9K	1	MR25	METAL FILM
R 532	5322 116 54665	40,2K	1	MR25	METAL FILM
R 533	5322 116 50767	2,15K	1	MR25	METAL FILM
R 534	5322 116 50559	27,4K	1	MR25	METAL FILM
R 536	5322 116 50608	6,19K	1	MR25	METAL FILM
R 537	5322 116 54005	3,32K	1	MR25	METAL FILM
R 538	5322 116 54623	11K	1	MR25	METAL FILM
R 540	5322 116 50536	464	1	MR25	METAL FILM
R 541	5322 116 54689	82,5K	1	MR25	METAL FILM
R 542	5322 116 50536	464	1	MR25	METAL FILM
R 543	5322 116 54623	11K	1	MR25	METAL FILM
R 544	5322 116 50557	46,4K	1	MR25	METAL FILM
R 546	5322 116 54627	13,3K	1	MR25	METAL FILM
R 547	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 548	5322 116 54576	2,37K	1	MR25	METAL FILM
R 549	5322 116 50608	6,19K	1	MR25	METAL FILM
R 550	5322 116 54619	10K	1	MR25	METAL FILM
R 551	5322 116 54005	3,32K	1	MR25	METAL FILM
R 552	5322 116 54623	11K	1	MR25	METAL FILM
R 553	5322 116 54689	82,5K	1	MR25	METAL FILM
R 554	5322 116 54623	11K	1	MR25	METAL FILM
R 555	5322 116 50536	464	1	MR25	METAL FILM
R 556	5322 116 50557	46,4K	1	MR25	METAL FILM
R 557	5322 116 50536	464	1	MR25	METAL FILM
R 558	5322 116 50557	46,4K	1	MR25	METAL FILM
R 559	5322 116 54623	11K	1	MR25	METAL FILM
R 560	5322 116 54743	301K	1	MR25	METAL FILM
R 561	5322 116 54619	10K	1	MR25	METAL FILM
R 562	5322 116 54641	19,6K	1	MR25	METAL FILM
R 563	5322 116 50729	4,22K	1	MR25	METAL FILM
R 564	4822 110 63187	1M	5	CR25	CARBON
R 565	5322 116 54549	1K	1	MR25	METAL FILM
R 566	4822 110 63187	1M	5	CR25	CARBON
R 567	4822 110 63161	100K	5	CR25	CARBON
R 568	5322 101 14094	1M	20	0,5W	TRIMMING POTM
R 569	4822 110 63187	1M	5	CR25	CARBON
R 570	4822 110 63107	1K	5	CR25	CARBON
R 571	4822 110 63187	1M	5	CR25	CARBON
R 572	5322 116 54619	10K	1	MR25	METAL FILM
R 573	4822 110 42223	22M	5	VR37	CARBON
R 574	4822 110 42216	12M	5	VR37	CARBON
R 575	5322 116 64029	5,6M	5	VR68	METAL OXIDE
R 576	4822 110 42205	4,7M	5	VR37	CARBON
R 577	4822 110 63196	2,2M	10	CR25	CARBON
R 578	4822 110 63196	2,2M	10	CR25	CARBON
R 579	5322 101 14094	1M	20	0,5W	TRIMMING POTM
R 580	5322 116 54549	1K	1	MR25	METAL FILM
R 581	5322 116 54619	10K	1	MR25	METAL FILM
R 582	5322 116 54701	110K	1	MR25	METAL FILM
R 583	5322 116 54701	110K	1	MR25	METAL FILM
R 584	5322 116 54674	53,6K	1	MR25	METAL FILM
R 585	5322 116 50491	22,6	1	MR25	METAL FILM
R 586	5322 116 54674	53,6K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 587	5322 101 14048	47K	20	0,5W	TRIMMING POTM
R 588	5322 101 14048	47K	20	0,5W	TRIMMING POTM
R 589	5322 101 14048	47K	20	0,5W	TRIMMING POTM
R 590	4822 111 30324	100	5	CR16	CARBON
R 591	5322 116 54469	100	1	MR25	METAL FILM
R 592	5322 116 54492	178	1	MR25	METAL FILM
R 593	5322 116 54482	133	1	MR25	METAL FILM
R 594	4822 116 51145	1,8K	5	PR37	METAL FILM
R 595	5322 116 54508	301	1	MR25	METAL FILM
R 596	5322 116 54641	19,6K	1	MR25	METAL FILM
R 597	4822 110 63107	1K	5	CR25	CARBON
R 600	5322 116 51052	42,2	1	MR25	METAL FILM
R 601	5322 116 54195	825K	1	MR30	METAL FILM
R 602	5322 116 54721	178K	1	MR25	METAL FILM
R 603	5322 116 50903	24,9	1	MR25	METAL FILM
R 604	5322 111 30396	22	5	CR16	CARBON
R 605	5322 116 54619	10K	1	MR25	METAL FILM
R 606	4822 110 63207	5,6M	10	CR25	CARBON
R 607	4822 110 63207	5,6M	10	CR25	CARBON
R 608	4822 111 30324	100	5	CR16	CARBON
R 609	5322 111 30396	22	5	CR16	CARBON
R 610	5322 116 54619	10K	1	MR25	METAL FILM
R 611	5322 116 54558	8,25K	1	MR25	METAL FILM
R 612	5322 116 54469	100	1	MR25	METAL FILM
R 613	5322 116 54541	825	1	MR25	METAL FILM
R 614	5322 116 50506	154	1	MR25	METAL FILM
R 615	5322 116 54497	226	1	MR25	METAL FILM
R 616	5322 116 54619	10K	1	MR25	METAL FILM
R 617	5322 116 50481	22,6K	1	MR25	METAL FILM
R 618	5322 116 54529	619	1	MR25	METAL FILM
R 619	4822 111 30348	27	5	CR16	CARBON
R 620	5322 116 50572	12,1K	1	MR25	METAL FILM
R 621	5322 111 30396	22	5	CR16	CARBON
R 622	5322 111 30074	56	5	CR16	CARBON
R 623	5322 116 54469	100	1	MR25	METAL FILM
R 624	5322 111 30074	56	5	CR16	CARBON
R 625	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 626	5322 116 54467	93,1	1	MR25	METAL FILM
R 627	5322 116 54529	619	1	MR25	METAL FILM
R 628	5322 116 54534	681	1	MR25	METAL FILM
R 629	5322 116 50621	536	1	MR25	METAL FILM
R 630	5322 116 50514	64,9K	1	MR25	METAL FILM
R 632	5322 111 30288	47K	5	CR16	CARBON
R 633	4822 111 30348	27	5	CR16	CARBON
R 634	5322 116 54446	56,2	1	MR25	METAL FILM
R 635	5322 111 30074	56	5	CR16	CARBON
R 636	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 637	5322 116 50524	3,01K	1	MR25	METAL FILM
R 638	5322 111 30074	56	5	CR16	CARBON
R 639	5322 116 54534	681	1	MR25	METAL FILM
R 640	5322 111 30396	22	5	CR16	CARBON
R 641	5322 116 50561	590	1	MR25	METAL FILM
R 642	5322 116 54469	100	1	MR25	METAL FILM
R 643	5322 111 30074	56	5	CR16	CARBON
R 644	5322 116 50524	3,01K	1	MR25	METAL FILM
R 645	5322 111 30074	56	5	CR16	CARBON
R 646	5322 116 50524	3,01K	1	MR25	METAL FILM
R 647	4822 111 30348	27	5	CR16	CARBON
R 648	5322 111 30074	56	5	CR16	CARBON
R 649	5322 116 54469	100	1	MR25	METAL FILM
R 650	5322 111 30074	56	5	CR16	CARBON
R 651	5322 116 50561	590	1	MR25	METAL FILM
R 652	5322 111 30074	56	5	CR16	CARBON
R 653	5322 116 54534	681	1	MR25	METAL FILM
R 654	5322 116 50524	3,01K	1	MR25	METAL FILM
R 655	5322 111 30074	56	5	CR16	CARBON

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 656	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 657	5322 116 50506	154	1	MR25	METAL FILM
R 658	4822 111 30348	27	5	CR16	CARBON
R 659	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 660	5322 111 30074	56	5	CR16	CARBON
R 661	5322 116 50524	3,01K	1	MR25	METAL FILM
R 662	5322 111 30074	56	5	CR16	CARBON
R 663	5322 116 54534	681	1	MR25	METAL FILM
R 664	5322 116 50561	590	1	MR25	METAL FILM
R 665	5322 111 30074	56	5	CR16	CARBON
R 666	5322 116 54469	100	1	MR25	METAL FILM
R 667	5322 111 30074	56	5	CR16	CARBON
R 668	5322 116 50524	3,01K	1	MR25	METAL FILM
R 669	5322 101 14066	10K	20	0,5W	TRIMMING POTM
R 670	5322 111 30396	22	5	CR16	CARBON
R 671	5322 111 30074	56	5	CR16	CARBON
R 672	5322 116 54469	100	1	MR25	METAL FILM
R 673	5322 116 50561	590	1	MR25	METAL FILM
R 674	5322 111 30074	56	5	CR16	CARBON
R 675	5322 111 30396	22	5	CR16	CARBON
R 676	5322 116 54534	681	1	MR25	METAL FILM
R 677	5322 116 50491	22,6	1	MR25	METAL FILM
R 678	5322 116 50524	3,01K	1	MR25	METAL FILM
R 679	5322 116 54696	100K	1	MR25	METAL FILM
R 680	5322 111 30396	22	5	CR16	CARBON
R 681	5322 116 50524	3,01K	1	MR25	METAL FILM
R 682	5322 116 54541	825	1	MR25	METAL FILM
R 683	5322 116 50557	46,4K	1	MR25	METAL FILM
R 684	5322 116 54011	5,62K	1	MR25	METAL FILM
R 685	5322 116 50491	22,6	1	MR25	METAL FILM
R 686	5322 116 54696	100K	1	MR25	METAL FILM
R 687	5322 116 50515	1,78K	1	MR25	METAL FILM
R 688	5322 116 50767	2,15K	1	MR25	METAL FILM
R 689	5322 116 54549	1K	1	MR25	METAL FILM
R 691	5322 116 54549	1K	1	MR25	METAL FILM
R 692	5322 116 50484	4,64K	1	MR25	METAL FILM
R 693	5322 116 54619	10K	1	MR25	METAL FILM
R 694	5322 116 54549	1K	1	MR25	METAL FILM
R 696	5322 116 50515	1,78K	1	MR25	METAL FILM
R 697	5322 116 50767	2,15K	1	MR25	METAL FILM
R 698	5322 116 50524	3,01K	1	MR25	METAL FILM
R 699	5322 116 54541	825	1	MR25	METAL FILM
R 700	5322 111 30396	22	5	CR16	CARBON
R 701	5322 116 54529	619	1	MR25	METAL FILM
R 702	5322 116 54536	750	1	MR25	METAL FILM
R 703	5322 116 54554	1,1K	1	MR25	METAL FILM
R 704	5322 111 30396	22	5	CR16	CARBON
R 705	5322 116 50491	22,6	1	MR25	METAL FILM
R 706	4822 111 30067	33	5	CR16	CARBON
R 707	5322 116 50586	1,69K	1	MR25R	METAL FILM
R 708	5322 116 50664	2,05K	1	MR25	METAL FILM
R 709	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 711	5322 116 54549	1K	1	MR25	METAL FILM
R 712	5322 101 14047	470	20	0,5W	TRIMMING POTM
R 713	5322 116 54619	10K	1	MR25	METAL FILM
R 714	5322 116 50586	1,54K	1	MR25	METAL FILM
R 716	5322 116 50484	4,64K	1	MR25	METAL FILM
R 717	5322 116 54549	1K	1	MR25	METAL FILM
R 718	5322 116 50586	1,54K	1	MR25	METAL FILM
R 719	5322 116 54529	619	1	MR25	METAL FILM
R 721	5322 116 54529	619	1	MR25	METAL FILM
R 722	5322 116 50572	12,1K	1	MR25	METAL FILM
R 723	5322 116 54549	1K	1	MR25	METAL FILM
R 724	5322 116 54529	619	1	MR25	METAL FILM
R 726	5322 116 54536	750	1	MR25	METAL FILM
R 727	5322 111 30396	22	5	CR16	CARBON
R 728	4822 111 30067	33	5	CR16	CARBON

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 729	5322 116 54554	1,1K	1	MR25	METAL FILM
R 731	5322 111 30396	22	5	CR16	CARBON
R 732	4822 111 30352	82	5	CR16	CARBON
R 733	5322 111 30396	22	5	CR16	CARBON
R 734	5322 116 54585	3,48K	1	MR25	METAL FILM
R 735	4822 111 30347	10	5	CR16	CARBON
R 736	5322 116 54592	4,02K	1	MR25	METAL FILM
R 737	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 738	5322 116 54624	11,5K	1	MR25	METAL FILM
R 739	5322 116 50515	1,78K	1	MR25	METAL FILM
R 741	5322 116 54558	8,25K	1	MR25	METAL FILM
R 742	5322 116 54549	1K	1	MR25	METAL FILM
R 743	4822 111 30324	100	5	CR16	CARBON
R 744	5322 116 54592	4,02K	1	MR25	METAL FILM
R 745	5322 111 30365	51	5	CR16	CARBON
R 746	5322 111 30396	22	5	CR16	CARBON
R 747	5322 111 44153	15	5	CR16	CARBON
R 748	5322 116 54515	348	1	MR25	METAL FILM
R 749	5322 116 54515	348	1	MR25	METAL FILM
R 751	5322 111 30396	22	5	CR16	CARBON
R 752	5322 111 44153	15	5	CR16	CARBON
R 753	5322 111 30396	22	5	CR16	CARBON
R 754	5322 111 30396	22	5	CR16	CARBON
R 755	4822 111 30347	10	5	CR16	CARBON
R 756	4822 111 30352	82	5	CR16	CARBON
R 757	5322 116 50572	12,1K	1	MR25	METAL FILM
R 758	5322 116 50524	3,01K	1	MR25	METAL FILM
R 759	5322 116 50484	4,64K	1	MR25	METAL FILM
R 761	5322 116 54508	301	1	MR25	METAL FILM
R 762	5322 116 54565	1,62K	1	MR25	METAL FILM
R 763	5322 111 30297	2K	5	CR16	CARBON
R 764	5322 116 54469	100	1	MR25	METAL FILM
R 765	5322 116 54469	100	1	MR25	METAL FILM
R 766	4822 111 30272	680	5	CR16	CARBON
R 767	4822 110 63036	2,2	5	CR25	CARBON
R 768	4822 110 63036	2,2	5	CR25	CARBON
R 769	4822 110 63036	2,2	5	CR25	CARBON
R 771	4822 110 63036	2,2	5	CR25	CARBON
R 801	4822 111 30347	10	5	CR16	CARBON
R 802	5322 116 50904	30,1	1	MR25	METAL FILM
R 803	5322 116 54508	301	1	MR25	METAL FILM
R 804	5322 116 50675	2,26K	1	MR25	METAL FILM
R 805	5322 116 54624	11,5K	1	MR25	METAL FILM
R 806	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 807	5322 116 54619	10K	1	MR25	METAL FILM
R 808	5322 116 50414	2,87K	1	MR25	METAL FILM
R 809	5322 116 54011	5,62K	1	MR25	METAL FILM
R 810	5322 116 54511	316	1	MR25	METAL FILM
R 811	5322 116 54587	3,65K	1	MR25	METAL FILM
R 812	5322 116 54482	133	1	MR25	METAL FILM
R 813	5322 116 54558	8,25K	1	MR25	METAL FILM
R 814	5322 116 50506	154	1	MR25	METAL FILM
R 816	5322 116 54613	8,66K	1	MR25	METAL FILM
R 817	5322 116 54619	10K	1	MR25	METAL FILM
R 818	5322 116 54549	1K	1	MR25	METAL FILM
R 819	5322 116 54442	51,1	1	MR25	METAL FILM
R 820	5322 116 50579	3,16K	1	MR25	METAL FILM
R 821	5322 116 50676	196	1	MR25	METAL FILM
R 822	5322 116 50491	22,6	1	MR25	METAL FILM
R 823	5322 116 50491	22,6	1	MR25	METAL FILM
R 824	5322 116 54595	5,11K	1	MR25	METAL FILM
R 825	5322 116 50452	10	1	MR25	METAL FILM
R 826	4822 111 30067	33	5	CR16	CARBON
R 827	5322 116 54619	10K	1	MR25	METAL FILM
R 828	5322 116 54608	7,5K	1	MR25	METAL FILM
R 829	5322 116 50664	2,05K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 831	5322 116 50636	2,74K	1	MR25	METAL FILM
R 834	5322 100 10114	4,7K	20	0,5W	TRIMMING POTM
R 836	5322 116 50481	22,6K	1	MR25	METAL FILM
R 837	5322 116 54632	14,7K	1	MR25	METAL FILM
R 838	5322 116 54721	178K	1	MR25	METAL FILM
R 839	5322 116 54479	127	1	MR25	METAL FILM
R 841	5322 116 50479	15,4K	1	MR25	METAL FILM
R 842	5322 116 54635	16,9K	1	MR25	METAL FILM
R 843	5322 116 54635	16,9K	1	MR25	METAL FILM
R 844	5322 116 50675	2,26K	1	MR25	METAL FILM
R 846	5322 116 50457	215	1	MR25	METAL FILM
R 847	5322 116 50414	2,87K	1	MR25	METAL FILM
R 848	5322 116 50509	4,87K	1	MR25	METAL FILM
R 849	5322 116 54562	1,4K	1	MR25	METAL FILM
R 850	5322 116 54009	562	1	MR25	METAL FILM
R 851	5322 116 54519	402	1	MR25	METAL FILM
R 852	5322 116 54532	649	1	MR25	METAL FILM
R 853	5322 116 50515	1,78K	1	MR25	METAL FILM
R 854	5322 116 50491	22,6	1	MR25	METAL FILM
R 855	5322 116 50559	27,4K	1	MR25	METAL FILM
R 856	5322 116 54009	562	1	MR25	METAL FILM
R 857	5322 116 54009	562	1	MR25	METAL FILM
R 858	5322 116 50559	27,4K	1	MR25	METAL FILM
R 859	5322 116 50559	27,4K	1	MR25	METAL FILM
R 860	5322 116 50675	2,26K	1	MR25	METAL FILM
R 861	5322 116 50675	2,26K	1	MR25	METAL FILM
R 862	5322 116 50675	2,26K	1	MR25	METAL FILM
R 863	5322 116 50636	2,74K	1	MR25	METAL FILM
R 864	5322 116 50636	2,74K	1	MR25	METAL FILM
R 865	5322 116 50636	2,74K	1	MR25	METAL FILM
R 866	5322 116 50452	10	1	MR25	METAL FILM
R 867	5322 116 50491	22,6	1	MR25	METAL FILM
R 868	5322 116 54641	19,6K	1	MR25	METAL FILM
R 869	5322 116 54587	3,65K	1	MR25	METAL FILM
R 870	5322 116 50728	1,87K	1	MR25	METAL FILM
R 871	5322 116 50726	36,5K	1	MR25	METAL FILM
R 872	5322 116 50726	36,5K	1	MR25	METAL FILM
R 873	5322 116 50491	22,6	1	MR25	METAL FILM
R 874	5322 116 50491	22,6	1	MR25	METAL FILM
R 875	4822 111 30311	3,9K	5	CR16	CARBON
R 876	4822 111 30245	47	5	CR16	CARBON
R 877	4822 111 30352	82	5	CR16	CARBON
R 878	5322 111 30279	33K	5	CR16	CARBON
R 881	5322 116 54655	30,1K	1	MR25	METAL FILM
R 882	5322 116 54549	1K	1	MR25	METAL FILM
R 883	5322 116 50536	464	1	MR25	METAL FILM
R 884	5322 116 54619	10K	1	MR25	METAL FILM
R 886	5322 116 54668	44,2K	1	MR25	METAL FILM
R 887	5322 116 54595	5,11K	1	MR25	METAL FILM
R 889	5322 116 54619	10K	1	MR25	METAL FILM
R 891	5322 116 50508	487	1	MR25	METAL FILM
R 893	5322 116 54637	17,8K	1	MR25	METAL FILM
R 894	5322 116 50572	12,1K	1	MR25	METAL FILM
R 896	5322 116 54689	82,5K	1	MR25	METAL FILM
R 897	5322 116 54608	7,5K	1	MR25	METAL FILM
R 898	5322 116 50459	422	1	MR25	METAL FILM
R 899	5322 116 54643	20,5K	1	MR25	METAL FILM
R 901	4822 110 63036	2,2	5	CR25	CARBON
R 902	4822 110 63036	2,2	5	CR25	CARBON
R 903	4822 110 63036	2,2	5	CR25	CARBON
R 904	4822 110 63036	2,2	5	CR25	CARBON
R 922	5322 116 54901	887K	0,25	MR54C	METAL FILM
R 923	5322 116 54896	354K	0,25	MR34C	METAL FILM
R 924	5322 116 54899	176K	0,25	MR34C	METAL FILM
R 926	5322 116 54976	88,7K	0,25	MR24C	METAL FILM
R 927	5322 116 54939	35,2K	0,25	MR24C	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 928	5322 116 50934	17,4K	0,25	MR24C	METAL FILM
R 929	5322 116 50615	8,56K	0,25	MR24C	METAL FILM
R 931	5322 116 55018	3,2K	0,25	MR24C	METAL FILM
R 932	5322 116 55017	1,42K	0,25	MR24C	METAL FILM
R 933	5322 116 54754	536	0,25	MR24C	METAL FILM
R 1000	5322 116 51052	42,2	1	MR25	METAL FILM
R 1001	5322 116 54195	825K	1	MR30	METAL FILM
R 1002	5322 116 54721	178K	1	MR25	METAL FILM
R 1005	5322 116 54619	10K	1	MR25	METAL FILM
R 1006	4822 110 63207	5,6M	10	CR25	CARBON
R 1007	4822 110 63207	5,6M	10	CR25	CARBON
R 1008	4822 111 30324	100	5	CR16	CARBON
R 1009	5322 111 30396	22	5	CR16	CARBON
R 1010	5322 116 54619	10K	1	MR25	METAL FILM
R 1013	5322 116 54541	825	1	MR25	METAL FILM
R 1014	5322 116 50506	154	1	MR25	METAL FILM
R 1015	5322 116 54497	226	1	MR25	METAL FILM
R 1018	5322 116 54529	619	1	MR25	METAL FILM
R 1019	4822 111 30348	27	5	CR16	CARBON
R 1020	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1022	5322 111 30074	56	5	CR16	CARBON
R 1023	5322 116 54469	100	1	MR25	METAL FILM
R 1024	5322 111 30074	56	5	CR16	CARBON
R 1025	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 1026	5322 116 54469	100	1	MR25	METAL FILM
R 1027	5322 116 54529	619	1	MR25	METAL FILM
R 1028	5322 116 54534	681	1	MR25	METAL FILM
R 1032	5322 111 30288	47K	5	CR16	CARBON
R 1033	4822 111 30348	27	5	CR16	CARBON
R 1035	5322 111 30074	56	5	CR16	CARBON
R 1036	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 1037	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1038	5322 111 30074	56	5	CR16	CARBON
R 1039	5322 116 54534	681	1	MR25	METAL FILM
R 1040	5322 111 30396	22	5	CR16	CARBON
R 1041	5322 116 50561	590	1	MR25	METAL FILM
R 1042	5322 116 54469	100	1	MR25	METAL FILM
R 1043	5322 111 30074	56	5	CR16	CARBON
R 1044	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1045	5322 111 30074	56	5	CR16	CARBON
R 1046	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1047	4822 111 30348	27	5	CR16	CARBON
R 1048	5322 111 30074	56	5	CR16	CARBON
R 1049	5322 116 54469	100	1	MR25	METAL FILM
R 1050	5322 111 30074	56	5	CR16	CARBON
R 1051	5322 116 50561	590	1	MR25	METAL FILM
R 1052	5322 111 30074	56	5	CR16	CARBON
R 1053	5322 116 54534	681	1	MR25	METAL FILM
R 1054	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1055	5322 111 30074	56	5	CR16	CARBON
R 1056	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 1057	5322 116 50506	154	1	MR25	METAL FILM
R 1058	4822 111 30348	27	5	CR16	CARBON
R 1070	5322 111 30396	22	5	CR16	CARBON
R 1079	5322 116 54696	100K	1	MR25	METAL FILM
R 1080	5322 111 30396	22	5	CR16	CARBON
R 1081	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1082	5322 116 54541	825	1	MR25	METAL FILM
R 1083	5322 116 50557	46,4K	1	MR25	METAL FILM
R 1084	5322 116 54011	5,62K	1	MR25	METAL FILM
R 1086	5322 116 54696	100K	1	MR25	METAL FILM
R 1087	5322 116 50515	1,78K	1	MR25	METAL FILM
R 1088	5322 116 50767	2,15K	1	MR25	METAL FILM
R 1089	5322 116 54549	1K	1	MR25	METAL FILM
R 1091	5322 116 54549	1K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 1092	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1093	5322 116 54619	10K	1	MR25	METAL FILM
R 1094	5322 116 54549	1K	1	MR25	METAL FILM
R 1096	5322 116 50515	1,78K	1	MR25	METAL FILM
R 1097	5322 116 50767	2,15K	1	MR25	METAL FILM
R 1098	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1099	5322 116 54541	825	1	MR25	METAL FILM
R 1100	5322 111 30396	22	5	CR16	CARBON
R 1101	5322 116 54529	619	1	MR25	METAL FILM
R 1102	5322 116 54536	750	1	MR25	METAL FILM
R 1103	5322 116 54554	1,1K	1	MR25	METAL FILM
R 1104	5322 111 30396	22	5	CR16	CARBON
R 1105	5322 116 50491	22,6	1	MR25	METAL FILM
R 1106	4822 111 30067	33	5	CR16	CARBON
R 1107	5322 116 54529	619	1	MR25	METAL FILM
R 1108	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1109	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 1111	5322 116 54549	1K	1	MR25	METAL FILM
R 1112	5322 101 14047	470	20	0,5W	TRIMMING POTM
R 1113	5322 116 54619	10K	1	MR25	METAL FILM
R 1114	5322 116 50586	1,54K	1	MR25	METAL FILM
R 1116	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1117	5322 116 54549	1K	1	MR25	METAL FILM
R 1118	5322 116 50586	1,54K	1	MR25	METAL FILM
R 1119	5322 116 54587	1,69K	1	MR25R	METAL FILM
R 1121	5322 116 54529	619	1	MR25	METAL FILM
R 1122	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1123	5322 116 54549	1K	1	MR25	METAL FILM
R 1124	5322 116 54529	619	1	MR25	METAL FILM
R 1125	5322 116 50491	22,6	1	MR25	METAL FILM
R 1126	5322 116 54536	750	1	MR25	METAL FILM
R 1127	5322 111 30396	22	5	CR16	CARBON
R 1128	4822 111 30067	33	5	CR16	CARBON
R 1129	5322 116 54554	1,1K	1	MR25	METAL FILM
R 1131	5322 111 30396	22	5	CR16	CARBON
R 1132	4822 111 30352	82	5	CR16	CARBON
R 1133	5322 111 30396	22	5	CR16	CARBON
R 1134	5322 116 54585	3,48K	1	MR25	METAL FILM
R 1135	4822 111 30347	10	5	CR16	CARBON
R 1136	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1137	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 1138	5322 116 54624	11,5K	1	MR25	METAL FILM
R 1139	5322 116 50515	1,78K	1	MR25	METAL FILM
R 1141	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1142	5322 116 54549	1K	1	MR25	METAL FILM
R 1143	5322 116 54469	100	1	MR25	METAL FILM
R 1144	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1145	5322 111 30365	51	5	CR16	CARBON
R 1146	5322 111 30396	22	5	CR16	CARBON
R 1147	5322 111 44153	15	5	CR16	CARBON
R 1148	5322 116 54515	348	1	MR25	METAL FILM
R 1149	5322 116 54515	348	1	MR25	METAL FILM
R 1151	5322 111 30396	22	5	CR16	CARBON
R 1152	5322 111 44153	15	5	CR16	CARBON
R 1153	5322 111 30396	22	5	CR16	CARBON
R 1154	5322 111 30396	22	5	CR16	CARBON
R 1155	4822 111 30347	10	5	CR16	CARBON
R 1156	4822 111 30352	82	5	CR16	CARBON
R 1157	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1158	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1159	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1160	5322 116 54469	100	1	MR25	METAL FILM
R 1161	5322 116 54508	301	1	MR25	METAL FILM
R 1162	5322 116 54565	1,62K	1	MR25	METAL FILM
R 1167	4822 110 63036	2,2	5	CR25	CARBON
R 1168	4822 110 63036	2,2	5	CR25	CARBON

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 1169	4822 110 63036	2,2	5	CR25	CARBON
R 1171	4822 110 63036	2,2	5	CR25	CARBON
R 1201	4822 111 30347	10	5	CR16	CARBON
R 1202	5322 116 50904	30,1	1	MR25	METAL FILM
R 1203	5322 116 54508	301	1	MR25	METAL FILM
R 1204	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1205	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1206	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 1207	5322 116 54619	10K	1	MR25	METAL FILM
R 1208	5322 116 54617	9,53K	1	MR25	METAL FILM
R 1209	5322 116 54011	5,62K	1	MR25	METAL FILM
R 1211	5322 116 54547	953	1	MR25	METAL FILM
R 1212	5322 116 54442	51,1	1	MR25	METAL FILM
R 1213	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1214	5322 116 54442	51,1	1	MR25	METAL FILM
R 1216	5322 116 50515	1,78K	1	MR25	METAL FILM
R 1217	5322 116 54549	1K	1	MR25	METAL FILM
R 1218	5322 116 54549	1K	1	MR25	METAL FILM
R 1219	5322 116 54442	51,1	1	MR25	METAL FILM
R 1220	5322 116 50579	3,16K	1	MR25	METAL FILM
R 1221	5322 116 50676	196	1	MR25	METAL FILM
R 1222	5322 116 50491	22,6	1	MR25	METAL FILM
R 1223	5322 116 50491	22,6	1	MR25	METAL FILM
R 1224	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1225	5322 116 54009	562	1	MR25	METAL FILM
R 1226	5322 116 54689	82,5K	1	MR25	METAL FILM
R 1227	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 1228	4822 111 30067	33	5	CR16	CARBON
R 1229	5322 116 54619	10K	1	MR25	METAL FILM
R 1230	5322 116 50559	27,4K	1	MR25	METAL FILM
R 1231	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1232	5322 116 54608	7,5K	1	MR25	METAL FILM
R 1233	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1234	5322 100 10114	4,7K	20	0,5W	TRIMMING POTM
R 1235	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1236	5322 116 50481	22,6K	1	MR25	METAL FILM
R 1237	5322 116 54009	562	1	MR25	METAL FILM
R 1238	5322 116 50559	27,4K	1	MR25	METAL FILM
R 1239	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1241	5322 116 54009	562	1	MR25	METAL FILM
R 1242	5322 116 50559	27,4K	1	MR25	METAL FILM
R 1243	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1244	5322 116 50491	22,6	1	MR25	METAL FILM
R 1246	5322 116 50491	22,6	1	MR25	METAL FILM
R 1247	4822 111 30245	47	5	CR16	CARBON
R 1248	4822 111 30352	82	5	CR16	CARBON
R 1249	5322 111 30279	33K	5	CR16	CARBON
R 1251	5322 116 54655	30,1K	1	MR25	METAL FILM
R 1252	5322 116 50457	215	1	MR25	METAL FILM
R 1253	5322 116 50414	2,87K	1	MR25	METAL FILM
R 1254	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1256	5322 116 50509	4,87K	1	MR25	METAL FILM
R 1257	5322 116 54562	1,4K	1	MR25	METAL FILM
R 1258	5322 116 54519	402	1	MR25	METAL FILM
R 1259	5322 116 54511	316	1	MR25	METAL FILM
R 1261	5322 116 54576	2,37K	1	MR25	METAL FILM
R 1262	5322 116 54508	301	1	MR25	METAL FILM
R 1263	5322 116 54011	5,62K	1	MR25	METAL FILM
R 1264	5322 116 54567	1,69K	1	MR25	METAL FILM
R 1266	5322 111 30396	22	5	CR16	CARBON
R 1267	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1268	5322 116 54608	7,5K	1	MR25	METAL FILM
R 1269	5322 111 30396	22	5	CR16	CARBON
R 1271	5322 116 50491	22,6	1	MR25	METAL FILM
R 1272	5322 116 54585	3,48K	1	MR25	METAL FILM
R 1273	5322 116 50558	18,7K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 1274	5322 116 54009	562	1	MR25	METAL FILM
R 1276	4822 110 63036	2,2	5	CR25	CARBON
R 1277	4822 110 63036	2,2	5	CR25	CARBON
R 1278	4822 110 63036	2,2	5	CR25	CARBON
R 1279	4822 110 63036	2,2	5	CR25	CARBON
R 1280	5322 116 50481	22,6K	1	MR25	METAL FILM
R 1281	5322 116 50586	1,54K	1	MR25	METAL FILM
R 1282	4822 111 30327	220	5	CR16	CARBON
R 1283	4822 111 30331	470	5	CR16	CARBON
R 1284	5322 116 54012	6,81K	1	MR25	METAL FILM
R 1286	5322 116 50556	4,42K	1	MR25	METAL FILM
R 1287	5322 116 54619	10K	1	MR25	METAL FILM
R 1303	5322 116 54896	354K	0,25	MR34C	METAL FILM
R 1304	5322 116 54899	176K	0,25	MR34C	METAL FILM
R 1306	5322 116 54976	88,7K	0,25	MR24C	METAL FILM
R 1307	5322 116 54939	35,2K	0,25	MR24C	METAL FILM
R 1308	5322 116 50934	17,4K	0,25	MR24C	METAL FILM
R 1309	5322 116 50615	8,56K	0,25	MR24C	METAL FILM
R 1311	5322 116 55018	3,2K	0,25	MR24C	METAL FILM
R 1312	5322 116 55017	1,42K	0,25	MR24C	METAL FILM
R 1313	5322 116 54754	536	0,25	MR24C	METAL FILM
R 1401	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 1402	5322 116 54619	10K	1	MR25	METAL FILM
R 1403	5322 116 54552	1,1K	1	MR25R	METAL FILM
R 1404	5322 116 50678	20,5	1	MR25	METAL FILM
R 1406	5322 116 50515	1,78K	1	MR25	METAL FILM
R 1407	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1408	5322 116 54516	365	1	MR25	METAL FILM
R 1409	5322 116 50731	10,5K	1	MR25	METAL FILM
R 1410	5322 100 10141	10K	20	0,75W	TRIMMING POTM
R 1411	5322 116 50414	2,37K	1	MR25R	METAL FILM
R 1412	5322 116 54446	56,2	1	MR25	METAL FILM
R 1413	5322 116 50592	442	1	MR25	METAL FILM
R 1414	5322 116 54567	1,69K	1	MR25	METAL FILM
R 1415	5322 116 54529	619	1	MR25	METAL FILM
R 1416	5322 116 50479	15,4K	1	MR25	METAL FILM
R1417	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1418	5322 116 50676	196	1	MR25	METAL FILM
R 1419	5322 100 10114	4,7K	20	0.5W	TRIMMING POTM
R 1421	5322 116 54541	825	1	MR25	METAL FILM
R 1422	5322 116 54541	825	1	MR25	METAL FILM
R 1423	5322 116 54525	511	1	MR25	METAL FILM
R 1424	5322 116 54525	511	1	MR25	METAL FILM
R 1426	5322 116 54508	301	1	MR25	METAL FILM
R 1427	5322 116 54508	301	1	MR25	METAL FILM
R 1428	5322 116 54585	3,48K	1	MR25	METAL FILM
R 1429	5322 116 50579	3,16K	1	MR25	METAL FILM
R 1431	5322 116 50569	95,3	1	MR25	METAL FILM
R 1432	5322 116 50569	95,3	1	MR25	METAL FILM
R 1433	5322 116 50728	1,87K	1	MR25	METAL FILM
R 1434	5322 116 54619	10K	1	MR25	METAL FILM
R 1436	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1437	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1438	5322 116 54554	1,1K	1	MR25	METAL FILM
R 1439	5322 116 54637	17,8K	1	MR25	METAL FILM
R 1441	5322 116 50568	4,99	1	MR25	METAL FILM
R 1442	5322 111 30396	22	5	CR16	CARBON
R 1443	5322 116 50568	4,99	1	MR25	METAL FILM
R 1444	5322 116 54529	619	1	MR25	METAL FILM
R 1445	5322 116 50457	215	1	MR25	METAL FILM
R 1446	5322 116 54506	287	1	MR25	METAL FILM
R 1447	5322 116 50635	1,47K	1	MR25	METAL FILM
R 1448	5322 116 54635	16,9K	1	MR25	METAL FILM
R 1449	5322 116 54643	20,5K	1	MR25	METAL FILM
R 1451	5322 116 54515	348	1	MR25	METAL FILM
R 1452	5322 116 50579	3,16K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 1453	5322 116 54608	7,5K	1	MR25	METAL FILM
R 1454	5322 100 10143	1K	20	0,75W	TRIMMING POTM
R 1456	5322 116 54506	287	1	MR25	METAL FILM
R 1457	5322 116 54619	10K	1	MR25	METAL FILM
R 1458	5322 116 54565	1,62K	1	MR25	METAL FILM
R 1459	5322 116 54615	9,09K	1	MR25	METAL FILM
R 1461	5322 116 50579	3,16K	1	MR25	METAL FILM
R 1462	5322 100 10141	10K	20	0,75W	TRIMMING POTM
R 1463	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1466	5322 116 54619	10K	1	MR25	METAL FILM
R 1467	5322 111 30396	22	5	CR16	CARBON
R 1468	5322 116 50509	4,87K	1	MR25	METAL FILM
R 1469	5322 116 50568	4,99	1	MR25	METAL FILM
R 1470	5322 116 50536	464	1	MR25	METAL FILM
R 1471	5322 116 54508	301	1	MR25	METAL FILM
R 1472	5322 116 50569	95,3	1	MR25	METAL FILM
R 1473	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1474	5322 111 30356	43	5	CR16	CARBON
R 1476	5322 116 54442	51,1	1	MR25	METAL FILM
R 1477	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1478	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1480	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1481	5322 116 54508	301	1	MR25	METAL FILM
R 1482	5322 116 54011	5,62K	1	MR25	METAL FILM
R 1483	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1484	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1485	5322 116 54009	562	1	MR25	METAL FILM
R 1486	5322 116 54508	301	1	MR25	METAL FILM
R 1487	5322 116 54624	11,5K	1	MR25	METAL FILM
R 1489	5322 111 30356	43	5	CR16	CARBON
R 1490	5322 116 54547	953	1	MR25	METAL FILM
R 1491	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1493	4822 111 30324	100	5	CR16	CARBON
R 1494	5322 116 54442	51,1	1	MR25	METAL FILM
R 1495	5322 116 54538	787	1	MR25	METAL FILM
R 1496	5322 116 54508	301	1	MR25	METAL FILM
R 1497	5322 116 50569	95,3	1	MR25	METAL FILM
R 1498	5322 100 10114	4,7K	20	0,5W	TRIMMING POTM
R 1499	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1501	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1502	5322 116 50568	4,99	1	MR25	METAL FILM
R 1503	5322 100 10133	220	20	0,75W	TRIMMING POTM
R 1504	5322 116 54474	110	1	MR25	METAL FILM
R 1506	5322 116 54603	6,49K	1	MR25	METAL FILM
R 1507	5322 116 54674	53,6K	1	MR25	METAL FILM
R 1508	5322 116 54589	3,83K	1	MR25	METAL FILM
R 1509	5322 116 50509	4,87K	1	MR25	METAL FILM
R 1511	5322 116 50766	147	1	MR25	METAL FILM
R 1512	5322 100 10133	220	20	0,75W	TRIMMING POTM
R 1513	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 1514	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 1516	5322 116 50766	147	1	MR25	METAL FILM
R 1517	5322 100 10133	220	20	0,75W	TRIMMING POTM
R 1518	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1519	5322 116 54665	40,2K	1	MR25	METAL FILM
R 1521	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1522	5322 116 54665	40,2K	1	MR25	METAL FILM
R 1601	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1602	5322 116 54466	90,9	1	MR25	METAL FILM
R 1603	5322 116 50417	162	1	MR25	METAL FILM
R 1604	5322 116 54562	1,4K	1	MR25	METAL FILM
R 1605	5322 116 54466	90,9	1	MR25	METAL FILM
R 1606	5322 116 54513	332	1	MR25	METAL FILM
R 1607	5322 116 54587	3,65K	1	MR25	METAL FILM
R 1608	5322 116 54565	1,62K	1	MR25	METAL FILM
R 1609	5322 116 50636	2,74K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 1611	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1612	5322 116 54525	511	1	MR25	METAL FILM
R 1613	5322 116 54561	1,33K	1	MR25	METAL FILM
R 1614	5322 116 54502	261	1	MR25	METAL FILM
R 1615	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1616	5322 116 50581	2,49K	1	MR25	METAL FILM
R 1617	5322 116 54561	1,33K	1	MR25	METAL FILM
R 1618	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1619	5322 116 50583	5,9K	1	MR25	METAL FILM
R 1620	5322 116 50671	2,61K	1	MR25	METAL FILM
R 1621	5322 116 54543	866	1	MR25	METAL FILM
R 1622	5322 116 50415	1,15K	1	MR25	METAL FILM
R 1623	5322 116 54552	1,05K	1	MR25	METAL FILM
R 1624	5322 116 50579	3,16K	1	MR25	METAL FILM
R 1625	5322 116 54543	866	1	MR25	METAL FILM
R 1626	5322 116 50671	2,61K	1	MR25	METAL FILM
R 1627	5322 116 54549	1K	1	MR25	METAL FILM
R 1628	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1629	5322 116 50414	2,87K	1	MR25	METAL FILM
R 1631	5322 116 54541	825	1	MR25	METAL FILM
R 1632	5322 116 54619	10K	1	MR25	METAL FILM
R 1633	5322 116 54513	332	1	MR25	METAL FILM
R 1634	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1635	5322 116 54525	511	1	MR25	METAL FILM
R 1636	5322 116 50508	487	1	MR25	METAL FILM
R 1637	5322 116 50536	464	1	MR25	METAL FILM
R 1638	5322 116 50767	2,15K	1	MR25	METAL FILM
R 1639	5322 116 54519	402	1	MR25	METAL FILM
R 1640	5322 116 54525	511	1	MR25	METAL FILM
R 1641	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1642	5322 116 50679	237	1	MR25	METAL FILM
R 1643	5322 116 50679	237	1	MR25	METAL FILM
R 1644	5322 116 54541	825	1	MR25	METAL FILM
R 1645	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1646	5322 116 54482	133	1	MR25	METAL FILM
R 1647	5322 116 54549	1K	1	MR25	METAL FILM
R 1648	5322 116 54541	825	1	MR25	METAL FILM
R 1649	5322 116 54482	133	1	MR25	METAL FILM
R 1651	5322 116 54549	1K	1	MR25	METAL FILM
R 1652	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1653	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1654	4822 110 63187	1M	5	CR25	CARBON
R 1656	5322 116 54549	1K	1	MR25	METAL FILM
R 1657	5322 101 14094	1M	20	0,5W	TRIMMING POTM
R 1666	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1667	5322 116 50557	46,4K	1	MR25	METAL FILM
R 1668	5322 111 44164	4,3	5	CR25	CARBON
R 1669	5322 116 50593	16,2K	1	MR25	METAL FILM
R 1671	5322 116 54606	7,15K	1	MR25	METAL FILM
R 1672	5322 116 54606	7,15K	1	MR25	METAL FILM
R 1673	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1674	5322 116 54549	1K	1	MR25	METAL FILM
R 1676	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1677	5322 116 54587	3,65K	1	MR25	METAL FILM
R 1678	5322 116 54455	68,1	1	MR25	METAL FILM
R 1679	5322 116 54587	3,65K	1	MR25	METAL FILM
R 1681	5322 116 54455	68,1	1	MR25	METAL FILM
R 1682	5322 111 44164	4,3	5	CR25	CARBON
R 1701	5322 116 54696	100K	1	MR25	METAL FILM
R 1702	4822 111 30245	47	5	CR16	CARBON
R 1703	5322 116 54009	562	1	MR25	METAL FILM
R 1704	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1705	5322 116 50558	18,7K	1	MR25	METAL FILM
R 1706	5322 111 30396	22	5	CR16	CARBON
R 1707	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1708	5322 111 30396	22	5	CR16	CARBON

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 1709	5322 116 54549	1K	1	MR25	METAL FILM
R 1711	4822 110 63174	330K	5	CR25	CARBON
R 1712	5322 111 30356	43	5	CR16	CARBON
R 1713	5322 116 54557	1,21K	1	MR25	METAL FILM
R 1714	5322 111 30356	43	5	CR16	CARBON
R 1716	5322 116 54557	1,21K	1	MR25	METAL FILM
R 1717	5322 116 50509	4,87K	1	MR25	METAL FILM
R 1718	5322 116 54587	3,65K	1	MR25	METAL FILM
R 1719	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1721	5322 111 30396	22	5	CR16	CARBON
R 1722	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1723	5322 116 54549	1K	1	MR25	METAL FILM
R 1724	4822 110 63165	150K	5	CR25	CARBON
R 1726	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1727	5322 111 30396	22	5	CR16	CARBON
R 1728	5322 116 54696	100K	1	MR25	METAL FILM
R 1729	4822 111 30245	47	5	CR16	CARBON
R 1730	5322 116 50558	18,7K	1	MR25	METAL FILM
R 1731	5322 116 54009	562	1	MR25	METAL FILM
R 1732	4822 110 63036	2,2	5	CR25	CARBON
R 1733	4822 110 63036	2,2	5	CR25	CARBON
R1802	4822 110 53027	1	5	CR27	CARBON
R 1803	5322 116 54743	301K	1	MR25	METAL FILM
R 1804	5322 116 54743	301K	1	MR25	METAL FILM
R 1805	5322 116 54035	24,9K	1	MR30	METAL FILM
R 1806	4822 110 63214	10M	10	CR25	CARBON
R 1807	4822 110 63196	2,2M	10	CR25	CARBON
R 1808	5322 116 54426	121	1	MR25	METAL FILM
R 1809	5322 116 54549	1K	1	MR25	METAL FILM
R 1810	5322 116 50557	46,4K	1	MR25	METAL FILM
R 1811	4822 112 21054	10	5	4.2W	WIRE-WOUND
R 1812	5322 116 54549	1K	1	MR25	METAL FILM
R 1813	5322 116 54619	2,05K	1	MR25R	METAL FILM
R 1814	5322 111 44195	10	5	0,5W	CARBON
R 1815	5322 116 34028	150K	5	0,5W	NTC
R 1817	5322 116 50442	48,7K	1	MR25	METAL FILM
R 1818	5322 116 54965	82	5	PR52	METAL FILM
R 1819	5322 116 54619	10K	1	MR25	METAL FILM
R 1820	5322 116 54549	1K	1	MR25	METAL FILM
R 1821	5322 116 54549	1K	1	MR25	METAL FILM
R 1822	5322 116 50731	10,5K	1	MR25	METAL FILM
R 1823	5322 116 54529	619	1	MR25	METAL FILM
R 1824	5322 116 54549	1K	1	MR25	METAL FILM
R 1825	5322 116 54469	100	1	MR25	METAL FILM
R 1826	5322 116 54574	2,21K	1	MR25	METAL FILM
R 1827	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1828	5322 100 10115	1K	20	0,5W	TRIMMING POTM
R 1829	5322 116 50586	1,54K	1	MR25	METAL FILM
R 1830	5322 116 50669	205	1	MR25	METAL FILM
R 1831	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1832	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1833	5322 116 54906	75	1	MR30	METAL FILM
R 1834	5322 116 54619	10K	1	MR25	METAL FILM
R 1835	5322 116 54014	23,7	1	MR25	METAL FILM
R 1836	5322 116 50559	27,4K	1	MR25	METAL FILM
R 1837	5322 116 54696	100K	1	MR25	METAL FILM
R 1838	4822 110 63187	1M	5	CR25	CARBON
R 1839	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1840	5322 116 54192	5,1	5	CR25	METAL FILM
R 1841	5322 116 54469	100	1	MR25	METAL FILM
R 1842	5322 116 54469	100	1	MR25	METAL FILM
R 1843	5322 116 54738	274K	1	MR25	METAL FILM
R 1844	5322 116 54619	10K	1	MR25	METAL FILM
R 1845	5322 116 50925	4,7	5	CR25R	METAL FILM
R 1846	5322 116 54726	100K	1	MR25R	METAL FILM
R 1847	5322 116 54726	100K	1	MR25R	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 1848	5322 116 54525	511	1	MR25	METAL FILM
R 1849	5322 116 55097	47	5	PR37	METAL FILM
R 1851	5322 116 34039	22	20	0,5W	NTC
R 1852	5322 116 54069	12,1	1	MR25	METAL FILM
R 1853	5322 116 54069	12,1	1	MR25	METAL FILM
R 1857	5322 116 54696	100K	1	MR25	METAL FILM
R 1858	5322 116 50904	30,1	1	MR25	METAL FILM
R 1901	5322 116 54469	100	1	MR25	METAL FILM
R 1902	5322 116 54641	19,6K	1	MR25	METAL FILM
R 1903	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1904	5322 116 54525	511	1	MR25	METAL FILM
R 1906	5322 100 10114	4,7K	20	0,5W	TRIMMING POTM
R 1907	5322 116 54538	787	1	MR25	METAL FILM
R 1908	5322 116 50415	1,15K	1	MR25	METAL FILM
R 1909	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1911	5322 116 54524	499	1	MR25	METAL FILM
R 1912	5322 116 54469	100	1	MR25	METAL FILM
R 2000	5322 116 54552	1,05K	1	MR25	METAL FILM
R 2001	5322 116 54497	226	1	MR25	METAL FILM
R 2002	4822 110 42187	1M	5	VR37	CARBON
R 2003	4822 110 42189	1,2M	5	VR37	CARBON
R 2004	5322 116 54619	10K	1	MR25	METAL FILM
R 2006	5322 116 54565	1,62K	1	MR25	METAL FILM
R 2007	5322 116 54469	46,4	1	MR25R	METAL FILM
R 2008	5322 116 50592	442	1	MR25	METAL FILM
R 2009	5322 116 50451	21,5K	1	MR25	METAL FILM
R 2010	5322 116 50557	46,4K	1	MR25	METAL FILM
R 2012	5322 116 54683	68,1K	1	MR25	METAL FILM
R 2013	5322 116 50636	2,74K	1	MR25	METAL FILM
R 2016	4822 110 63178	470K	5	CR25	CARBON
R 2024	4822 110 42214	10M	5	VR37	CARBON

ITEM	ORDERING NUMBER	TYPE/DESCRIPTION
DIODES		
GR1	5322 130 34595	CQY24A-I
GR2	5322 130 34595	CQY24A-I
GR3	5322 130 34595	CQY24A-I
GR101	5322 130 34037	BAV45
GR201	5322 130 30613	BAW62
GR202	5322 130 30613	BAW62
GR203	5322 130 30613	BAW62
GR204	5322 130 30766	BZX79-C6V2
GR208	5322 130 30773	BZX79-C4V7
GR301	5322 130 30613	BAW62
GR302	5322 130 30613	BAW62
GR303	5322 130 30613	BAW62
GR304	5322 130 30613	BAW62
GR306	5322 130 30613	BAW62
GR307	5322 130 30613	BAW62
GR311	5322 130 30613	BAW62
GR312	5322 130 30613	BAW62
GR313	5322 130 30742	1N825
GR314	5322 130 30613	BAW62
GR316	5322 130 30742	1N825
GR321	5322 130 30613	BAW62
GR322	5322 130 30613	BAW62
GR323	5322 130 30742	1N825
GR324	5322 130 30613	BAW62
GR326	5322 130 30742	1N825
GR401	5322 130 34049	BZX75-C2V1
GR402	5322 130 30773	BZX79-C4V7
GR403	5322 130 30613	BAW62
GR404	5322 130 30768	BZX79-C6V8

ITEM	ORDERING NUMBER	TYPE/DESCRIPTION
GR406	5322 130 30613	BAW62
GR407	5322 130 34511	SELECTED
GR408	5322 130 30613	BAW62
GR409	5322 130 30613	BAW62
GR501	5322 130 30613	BAW62
GR502	5322 130 30759	BZX79-C5V6
GR503	5322 130 30767	BZX79-C5V1
GR504	5322 130 34189	BAV20
GR505	5322 130 30613	BAW62
GR506	5322 130 30613	BAW62
GR507	5322 130 30759	BZX79-C5V6
GR508	5322 130 30605	BAX17
GR509	5322 130 30605	BAX17
GR510	5322 130 30605	BAX17
GR511	5322 130 30605	BAX17
GR512	5322 130 30605	BAX17
GR513	5322 130 34383	BZX79-C47
GR514	5322 130 30605	BAX17
GR515	5322 130 30605	BAX17
GR516	5322 130 30605	BAX17
GR517	5322 130 30605	BAX17
GR518	5322 130 30605	BAX17
GR519	5322 130 30424	BAX12
GR521	5322 130 30766	BZX79-C6V2
GR600	5322 130 34337	BAV99
GR601	5322 130 34337	BAV99
GR602	5322 130 34331	BAV70
GR603	5322 130 30613	BAW62
GR604	5322 130 30613	BAW62
GR606	5322 130 30765	BZX75-C3V6
GR801	5322 130 30613	BAW62
GR802	5322 130 30613	BAW62
GR803	5322 130 30613	BAW62
GR804	5322 130 30613	BAW62
GR807	5322 130 30613	BAW62
GR808	5322 130 30613	BAW62
GR809	5322 130 30613	BAW62
GR811	5322 130 30613	BAW62
GR812	5322 130 30613	BAW62
GR813	5322 130 30613	BAW62
GR1000	5322 130 34337	BAV99
GR1001	5322 130 34337	BAV99
GR1002	5322 130 34331	BAV70
GR1003	5322 130 30613	BAW62
GR1004	5322 130 30613	BAW62
GR1006	5322 130 30765	BZX75-C3V6
GR1201	5322 130 30613	BAW62
GR1202	5322 130 30613	BAW62
GR1203	5322 130 30613	BAW62
GR1204	5322 130 30613	BAW62
GR1206	5322 130 30613	BAW62
GR1207	5322 130 30613	BAW62
GR1401	5322 130 30613	BAW62
GR1402	5322 130 30613	BAW62
GR1403	5322 130 30613	BAW62
GR1404	5322 130 30613	BAW62
GR1406	5322 130 30613	BAW62
GR1407	5322 130 30613	BAW62
GR1408	5322 130 30613	BAW62
GR1601	5322 130 30613	BAW62
GR1602	5322 130 30613	BAW62
GR1603	5322 130 30613	BAW62
GR1604	5322 130 30613	BAW62
GR1606	5322 130 30613	BAW62
GR1607	5322 130 30424	BAX12
GR1608	5322 130 30613	BAW62

ITEM	ORDERING NUMBER	TYPE/DESCRIPTION
GR1609	5322 130 30613	BAW62
GR1620	5322 130 34197	BZX79-C12
GR1701	5322 130 30767	BZX79-C5V1
GR1702	5322 130 34328	BZX79/B30
GR1703	5322 130 34173	BZX79-B5V6
GR1704	5322 130 34145	BZX79-B39
GR1706	5322 130 34329	BZX79/B43
GR1707	5322 130 30767	BZX79-C5V1
GR1801	4822 130 30817	BYX55/600
GR1802	4822 130 30817	BYX55/600
GR1803	4822 130 30817	BYX55/600
GR1804	4822 130 30817	BYX55/600
GR1806	4822 130 30839	BY206
GR1807	4822 130 30839	BY206
GR1809	4822 130 20039	BR 100
GR1810	5322 130 30424	BAX12
GR1811	4822 130 30817	BYX55/600
GR1812	5322 130 34297	BZX79-C10
GR1813	5322 130 34034	BZX61-C75
GR1814	5322 130 30565	BZX61-C47
GR1815	5322 130 30767	BZX79-C5V1
GR1816	4822 130 30817	BYX55/600
GR1818	5322 130 30613	BAW62
GR1819	5322 130 34048	BZX75-C2V8
GR1820	5322 130 30613	BAW62
GR1821	4822 130 30839	BY206
GR1822	4822 130 30839	BY206
GR1823	5322 130 30613	BAW62
GR1824	4822 130 30839	BY206
GR1825	5322 130 30424	BAX12
GR1826	4822 130 30839	BY206
GR1827	4822 130 30839	BY206
GR1828	5322 130 30613	BAW62
GR1831	4822 130 30839	BY206
GR1832	4822 130 30839	BY206
GR1833	4822 130 30839	BY206
GR1834	4822 130 30839	BY206
GR1836	4822 130 30839	BY206
GR1837	4822 130 30839	BY206
GR1838	4822 130 30839	BY206
GR1839	4822 130 30839	BY206
GR1841	4822 130 30839	BY206
GR1842	4822 130 30839	BY206
GR1843	4822 130 30839	BY206
GR1844	4822 130 30839	BY206
GR1846	4822 130 30839	BY206
GR1847	4822 130 30817	BYX55/600
GR1848	4822 130 30839	BY206
GR1849	4822 130 30839	BY206
GR1851	4822 130 30817	BYX55/600
GR1901	5322 130 30759	BZX79-C5V6
GR2001	5322 130 34594	BY409
GR2002	5322 130 30424	BAX12
GR2003	4822 130 30839	BY206
GR2006	5322 130 30613	BAW62
GR2013	5322 130 34594	BY409
GR2014	5322 130 34594	BY409
GR2016	5322 130 34594	BY409
GR2017	5322 130 34594	BY409
GR2018	5322 130 34594	BY409
GR2019	5322 130 34594	BY409
GR2021	5322 130 34594	BY409
GR2022	5322 130 34594	BY409
GR2023	5322 130 34594	BY409

ITEM	ORDERING NUMBER	TYPE/DESCRIPTION
TRANSISTORS		
TS101	5322 130 44605	ON471
TS102	5322 130 44459	BFT25R
TS103	5322 130 44606	BFR92R
TS200	4822 130 40941	BC558
TS201	4822 130 40941	BC558
TS202	5322 130 44458	BFT25
TS203	4822 130 40941	BC558
TS204	5322 130 44458	BFT25
TS205	4822 130 40938	BC548
TS206	5322 130 44459	BFT25R
TS207	4822 130 40941	BC558
TS208	4822 130 40938	BC548
TS209	4822 130 40938	BC548
TS211	4822 130 40938	BC548
TS301	4822 130 40941	BC558
TS302	5322 130 44458	BFT25
TS303	4822 130 40941	BC558
TS304	5322 130 44459	BFT25R
TS306	5322 130 44458	BFT25
TS307	4822 130 40941	BC558
TS308	4822 130 40938	BC548
TS309	4822 130 40938	BC548
TS321	4822 130 40941	BC558
TS322	4822 130 40938	BC548
TS323	4822 130 40941	BC558
TS331	4822 130 40941	BC558
TS332	4822 130 40938	BC548
TS333	4822 130 40941	BC558
TS401	5322 130 44344	BFR64R
TS402	5322 130 44344	BFR64R
TS501	5322 130 44246	BC549C
TS502	4822 130 40941	BC558
TS503	4822 130 40964	BC549
TS504	5322 130 44396	BF324
TS506	5322 130 40672	BFW44
TS507	4822 130 40908	BF336
TS508	4822 130 40908	BF336
TS509	5322 130 40493	BFY90
TS511	5322 130 44256	BC557
TS512	4822 130 40968	BSS38
TS513	5322 130 44256	BC557
TS514	4822 130 40968	BSS38
TS516	4822 130 40964	BC549
TS518	4822 130 40968	BSS38
TS519	4822 130 40941	BC558
TS521	4822 130 40938	BC548
TS522	4822 130 40941	BC558
TS523	4822 130 40938	BC548
TS524	4822 130 40941	BC558
TS526	4822 130 40938	BC548
TS527	5322 130 40645	BD 135
TS528	5322 130 40665	BD138
TS601	5322 130 44361	ON475
TS602	5322 130 44337	BCW33
TS603	5322 130 44338	BFS17R
TS604	5322 130 40781	BFS17
TS607	5322 130 44338	BFS17R
TS608	5322 130 44338	BFS17R
TS609	5322 130 44342	BCW33R
TS611	5322 130 44338	BFS17R
TS612	5322 130 44342	BCW33R
TS613	5322 130 40781	BFS17
TS614	5322 130 40781	BFS17
TS616	5322 130 44342	BCW33R

ITEM	ORDERING NUMBER	TYPE/DESCRIPTION
TS617	5322 130 44338	BFS17R
TS618	5322 130 40781	BFS17
TS619	5322 130 44338	BFS17R
TS621	5322 130 44342	BCW33R
TS622	5322 130 40781	BFS17
TS623	5322 130 44337	BCW33
TS624	5322 130 44342	BCW33R
TS626	5322 130 44337	BCW33
TS627	5322 130 44338	BFS17R
TS628	5322 130 44335	BCW30
TS629	5322 130 44335	BCW30
TS631	5322 130 44341	BCW30R
TS632	5322 130 44341	BCW30R
TS633	5322 130 40781	BFS17
TS634	5322 130 44337	BCW33
TS636	5322 130 44337	BCW33
TS637	5322 130 44335	BCW30
TS638	5322 130 44335	BCW30
TS639	5322 130 44341	BCW30R
TS641	5322 130 44342	BCW33R
TS642	5322 130 44342	BCW33R
TS643	5322 130 44338	BFS17R
TS644	5322 130 40781	BFS17
TS646	5322 130 40781	BFS17
TS647	5322 130 44338	BFS17R
TS648	5322 130 44356	537BSY-R
TS649	5322 130 44338	BFS17R
TS801	5322 130 40781	BFS17
TS802	5322 130 40781	BFS17
TS803	5322 130 40781	BFS17
TS804	5322 130 40781	BFS17
TS805	5322 130 44342	BCW33R
TS806	5322 130 40373	BCY71
TS807	5322 130 44336	BSV52
TS808	5322 130 44336	BSV52
TS809	5322 130 44342	BCW33R
TS811	5322 130 44337	BCW33
TS812	5322 130 44342	BCW33R
TS813	5322 130 44342	BCW33R
TS814	5322 130 44338	BFS17R
TS815	5322 130 44339	BFS19R
TS816	5322 130 44359	537BSY
TS817	5322 130 44359	537BSY
TS818	5322 130 44356	537BSY-R
TS819	5322 130 44339	BFS19R
TS820	5322 130 44339	BFS19R
TS821	5322 130 44339	BFS19R
TS822	5322 130 44339	BFS19R
TS823	5322 130 44339	BFS19R
TS824	5322 130 44342	BCW33R
TS825	5322 130 44337	BCW33
TS826	5322 130 44337	BCW33
TS827	5322 130 30187	BCY88
TS828	4822 130 40941	BC558
TS829	5322 130 44342	BCW33R
TS831	5322 130 44342	BCW33R
TS1001	5322 130 44361	ON475
TS1003	5322 130 40781	BFS17
TS1004	5322 130 44338	BFS17R
TS1007	5322 130 40781	BFS17
TS1008	5322 130 40781	BFS17
TS1011	5322 130 40781	BFS17
TS1012	5322 130 44337	BCW33
TS1013	5322 130 44338	BFS17R
TS1014	5322 130 44338	BFS17R
TS1016	5322 130 44337	BCW33
TS1017	5322 130 40781	BFS17

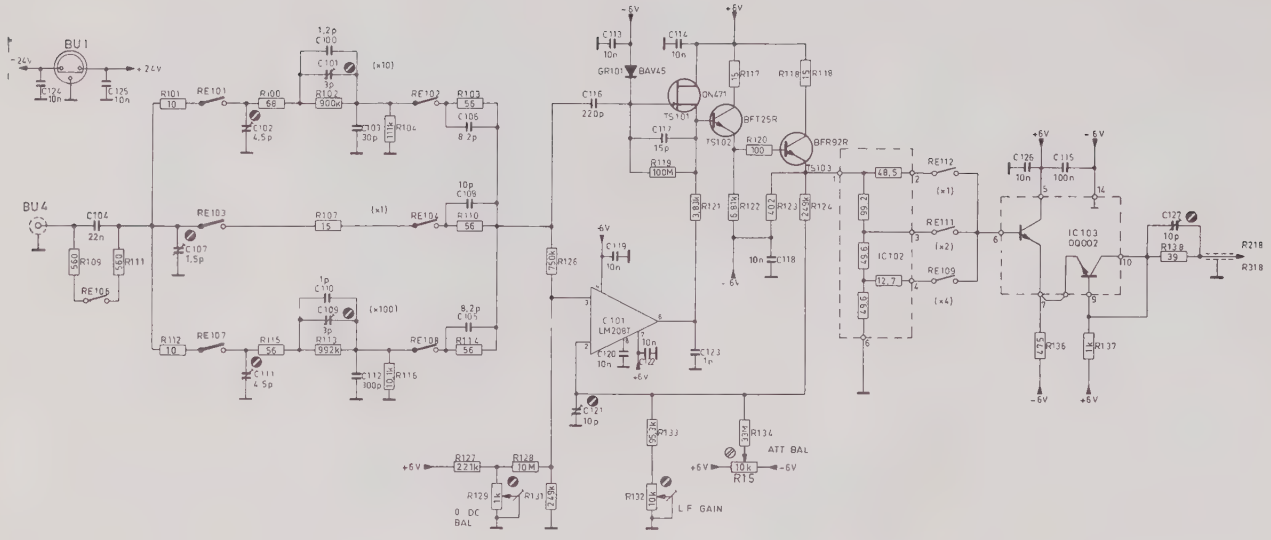
ITEM	ORDERING NUMBER	TYPE/DESCRIPTION
TS1018	5322 130 44338	BFS17R
TS1027	5322 130 44338	BFS17R
TS1028	5322 130 44341	BCW30R
TS1029	5322 130 44335	BCW30
TS1031	5322 130 44341	BCW30R
TS1032	5322 130 44341	BCW30R
TS1033	5322 130 40781	BFS17
TS1034	5322 130 44337	BCW33
TS1036	5322 130 44342	BCW33R
TS1037	5322 130 44335	BCW30
TS1038	5322 130 44335	BCW30
TS1039	5322 130 44341	BCW30R
TS1041	5322 130 44342	BCW33R
TS1042	5322 130 44342	BCW33R
TS1043	5322 130 44338	BFS17R
TS1044	5322 130 40781	BFS17
TS1046	5322 130 40781	BFS17
TS1047	5322 130 44338	BFS17R
TS1201	5322 130 40781	BFS17
TS1202	5322 130 40781	BFS17
TS1203	5322 130 40781	BFS17
TS1204	5322 130 40781	BFS17
TS1205	5322 130 44396	BF324
TS1206	5322 130 40373	BCY71
TS1207	5322 130 44336	BSV52
TS1208	5322 130 44336	BSV52
TS1209	5322 130 44337	BCW33
TS1210	5322 130 44339	BFS19R
TS1211	5322 130 44342	BCW33R
TS1212	5322 130 44339	BFS19R
TS1213	5322 130 44339	BFS19R
TS1214	5322 130 44337	BCW33
TS1216	5322 130 44337	BCW33
TS1217	5322 130 40781	BFS17
TS1218	5322 130 44359	537BSY
TS1219	5322 130 44359	537BSY
TS1221	5322 130 44359	537BSY
TS1222	5322 130 44356	537BSY-R
TS1223	5322 130 44356	537BSY-R
TS1224	5322 130 44342	BCW33R
TS1226	5322 130 30187	BCY88
TS1227	5322 130 44337	BCW33
TS1400	5322 130 44197	BC558B
TS1401	5322 130 44197	BC558B
TS1402	4822 130 40938	BC548
TS1403	5322 130 44093	BSV78
TS1404	5322 130 44337	BCW33
TS1405	4822 130 40938	BC548
TS1406	5322 130 44337	BCW33
TS1407	5322 130 44342	BCW33R
TS1408	5322 130 44337	BCW33
TS1409	5322 130 44337	BCW33
TS1410	5322 130 44337	BCW33
TS1411	5322 130 44335	BCW30
TS1412	5322 130 44337	BCW33
TS1413	5322 130 44342	BCW33R
TS1414	5322 130 44337	BCW33
TS1416	5322 130 44337	BCW33
TS1417	5322 130 44342	BCW33R
TS1418	5322 130 44337	BCW33
TS1419	5322 130 44335	BCW30
TS1421	5322 130 44335	BCW30
TS1422	5322 130 44335	BCW30
TS1423	5322 130 44335	BCW30
TS1424	5322 130 44335	BCW30
TS1426	5322 130 44359	537BSY

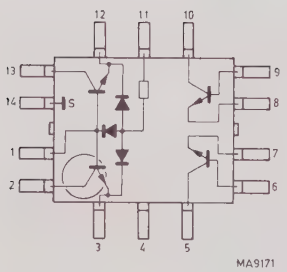
ITEM	ORDERING NUMBER	TYPE/DESCRIPTION
TS1427	5322 130 44335	BCW30
TS1428	5322 130 44335	BCW30
TS1429	5322 130 44335	BCW30
TS1431	5322 130 44335	BCW30
TS1432	5322 130 44335	BCW30
TS1433	5322 130 44335	BCW30
TS1601	5322 130 40417	BSX20
TS1602	5322 130 40417	BSX20
TS1603	5322 130 44396	BF324
TS1604	4822 130 40941	BC558
TS1605	4822 130 40941	BC558
TS1606	4822 130 40938	BC548
TS1607	5322 130 44396	BF324
TS1608	5322 130 44396	BF324
TS1609	5322 130 44396	BF324
TS1611	5322 130 44396	BF324
TS1612	4822 130 40938	BC548
TS1613	5322 130 40417	BSX20
TS1614	4822 130 40938	BC548
TS1616	4822 130 40941	BC558
TS1617	4822 130 40941	BC558
TS1618	5322 130 44353	BF256C
TS1621	4822 130 40941	BC558
TS1622	4822 130 40941	BC558
TS1623	5322 130 44357	BD262
TS1625	4822 130 40941	BC558
TS1701	5322 130 40672	BFW44
TS1702	4822 130 40908	BF336
TS1703	5322 130 40417	BSX20
TS1704	5322 130 44396	BF324
TS1706	5322 130 44396	BF324
TS1707	5322 130 44127	2N2894A
TS1708	5322 130 40672	BFW44
TS1709	4822 130 40908	BF336
TS1801	5322 130 44457	BDY93/01
TS1802	5322 130 24009	BTX18-500
TS1803	5322 130 44406	
TS1806	5322 130 44019	BSX60
TS1807	5322 130 44246	BC549C
TS1808	5322 130 40482	BRY39
TS1809	5322 130 44395	CNY43
TS1811	4822 130 40963	BC559
TS1812	5322 130 44246	BC549C
TS1813	5322 130 44246	BC549C
TS2001	5322 130 44462	BC556A
TS2002	4822 130 40959	BC547B
TS2003	5322 130 44461	BC546B
TS2004	5322 130 40714	BSW68

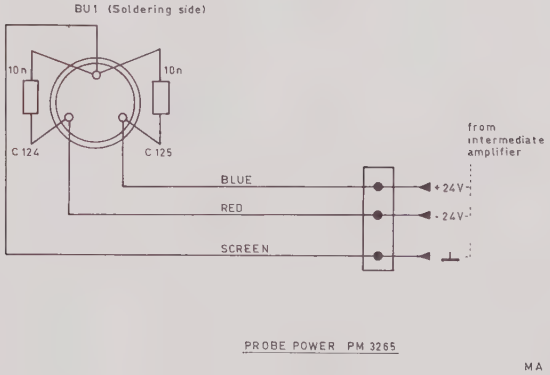
ITEM	ORDERING NUMBER	TYPE/DESCRIPTION
INTEGRATED CIRCUITS		
IC101	5322 209 85475	LM208T
IC102	5322 111 94032	TF CIRC
IC103	5322 209 84355	OQ 002
IC201	5322 209 84427	TF CIRCUIT
IC202	5322 209 84425	TF CIRCUIT
IC203	5322 209 84342	741HC
IC204	5322 209 84426	TF CIRCUIT
IC206	5322 209 84785	TF CIRCUIT
IC207	5322 209 84786	TF CIRCUIT
IC208	5322 209 84428	TF CIRCUIT
IC209	5322 209 84787	TF CIRCUIT
IC301	5322 209 84427	TF CIRCUIT

ITEM	ORDERING NUMBER	TYPE/DESCRIPTION
IC302	5322 209 84425	TF CIRCUIT
IC303	5322 209 84342	741HC
IC304	5322 209 84426	TF CIRCUIT
IC401	5322 209 84483	TF CIRCUIT
IC402	5322 209 84484	TF CIRCUIT } £36.72 each.
IC403	5322 209 84484	TF CIRCUIT
IC601	5322 209 84485	TF CIRCUIT
IC1001	5322 209 84485	TF CIRCUIT
IC1601	5322 209 84528	N7400A
IC1602	5322 209 84286	N7451A
IC1603	5322 209 84546	N7476B
IC1604	5322 209 84512	N7426A
IC1614	5322 209 84899	LM723CH
IC1801	5322 209 84899	LM723CH
IC1901	5322 209 84452	709HC

ITEM	ORDERING NUMBER	TYPE/DESCRIPTION
MISCELLANEOUS		
B 1	5322 131 24022	D14-240GH/08
B 501	5322 131 90021	ZA1004
B 502	5322 131 90021	ZA1004
BU1	5322 265 30096	CONTRASTEKER 3 POL
L 401/L 404	5322 466 14132	FILTER
L 406/L 409	5322 466 14132	FILTER
L 391	5322 281 64154	COIL
L 411	5322 158 14121	L-R COMBINATIE
L 412	5322 158 14121	L-R COMBINATIE
L 501	5322 150 14013	ESB CORR COIL
L 1601	5322 158 10243	COIL
L 1800	5322 281 64154	COIL
L 1801	5322 158 14171	COIL
L 1802	5322 158 14171	COIL
L 1803	5322 281 64154	COIL
L 1804	5322 158 34068	SMOORSPOEL
L 1805	5322 156 14076	COIL
L 1806	5322 281 64154	COIL
L 1807	5322 156 44014	COIL
L 1809	5322 156 44014	COIL
L 1812	5322 156 44014	COIL
L 1814	5322 156 44014	COIL
L 1817	5322 156 44014	COIL
L 1819	5322 156 44014	COIL
L 1822	5322 156 44014	COIL
L 2001	5322 281 64154	COIL
LA1	5322 134 44123	LAMP 18V/40MA
LA2	5322 134 44123	LAMP 18V/40MA
RE101	5322 280 24076	RELAY COIL
RE102	5322 280 24076	RELAY COIL
RE103	5322 280 24076	RELAY COIL
RE104	5322 280 24076	RELAY COIL
RE106	5322 280 24076	RELAY COIL
RE107	5322 280 24076	RELAY COIL
RE108	5322 280 24076	RELAY COIL
RE109	5322 280 24076	RELAY COIL
RE111	5322 280 24076	RELAY COIL
RE112	5322 280 24076	RELAY COIL
	5322 276 14158	PUSH-BUTTON SWITCH SINGLE-SEGMENT
T 1801	5322 146 14069	TRAFO FXC
T 1802	5322 142 64062	CONVERTER TRAFO
T 2001	5322 142 64018	TRAFO FXC E30
VL1	4822 253 30025	FUSE 2 A SLOW







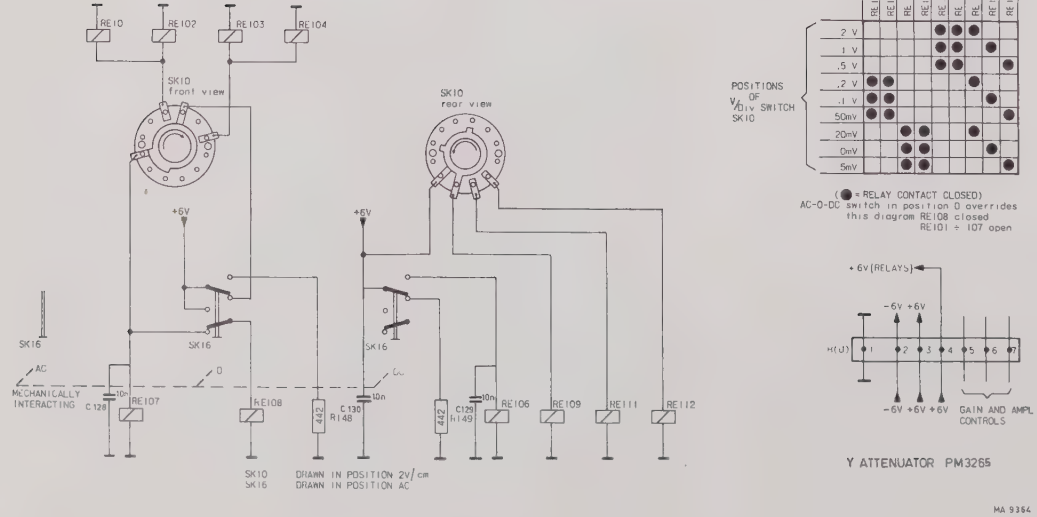

SK10 front view
SK10 rear view
SK16
MECHANICALLY INTERACTING
DRAWN IN POSITION 2V/cm
DRAWN IN POSITION AC
POSITIONS OF V/Div SWITCH SK10
(● = RELAY CONTACT CLOSED)
AC-O-DC switch in position O overrides this diagram RE108 closed RE101 - 107 open
+6V (RELAYS)
GAIN AND AMPL CONTROLS
Y ATTENUATOR PM3265
MA 9364

Fig. 3.26. Y Attenuator

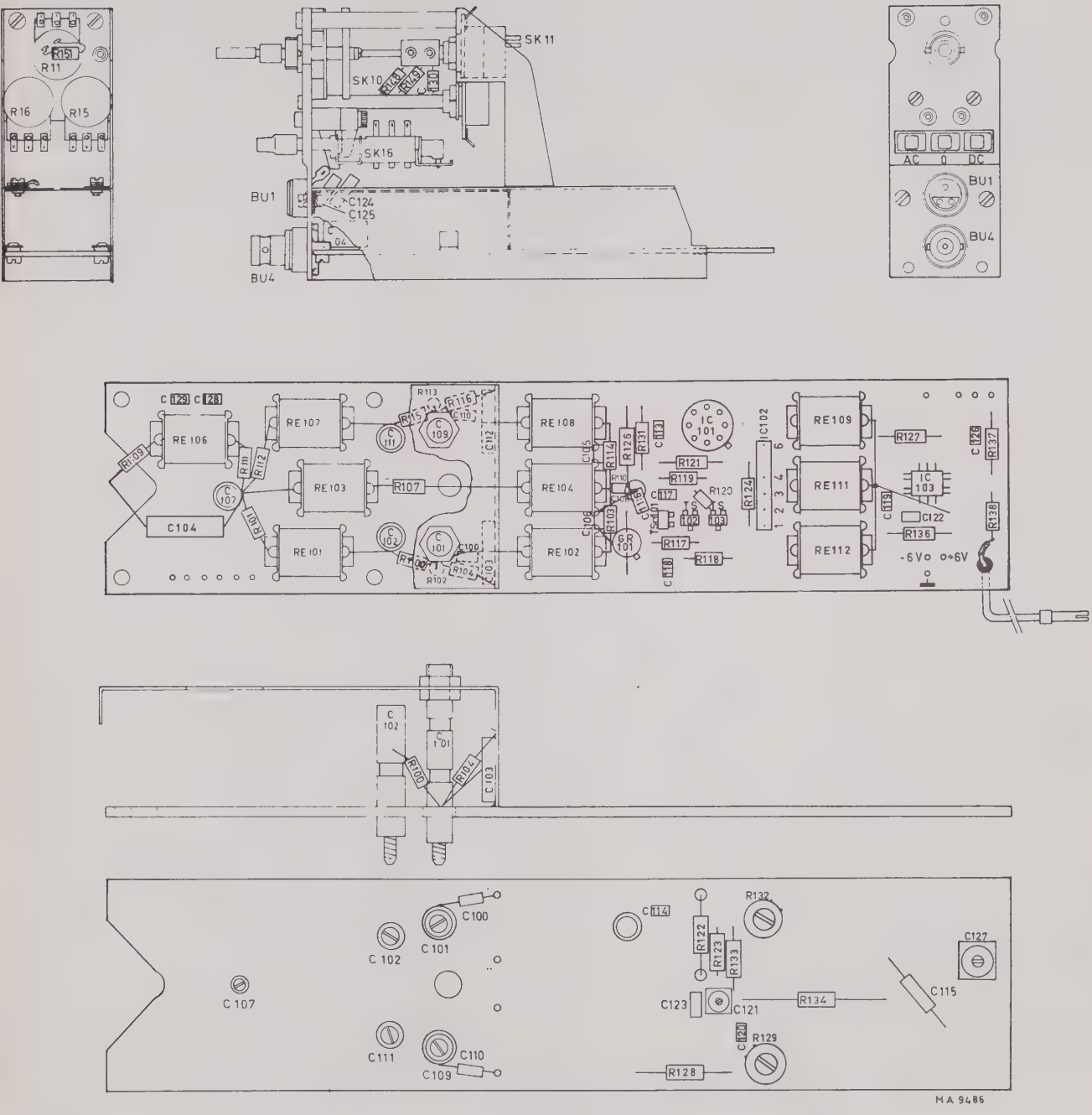
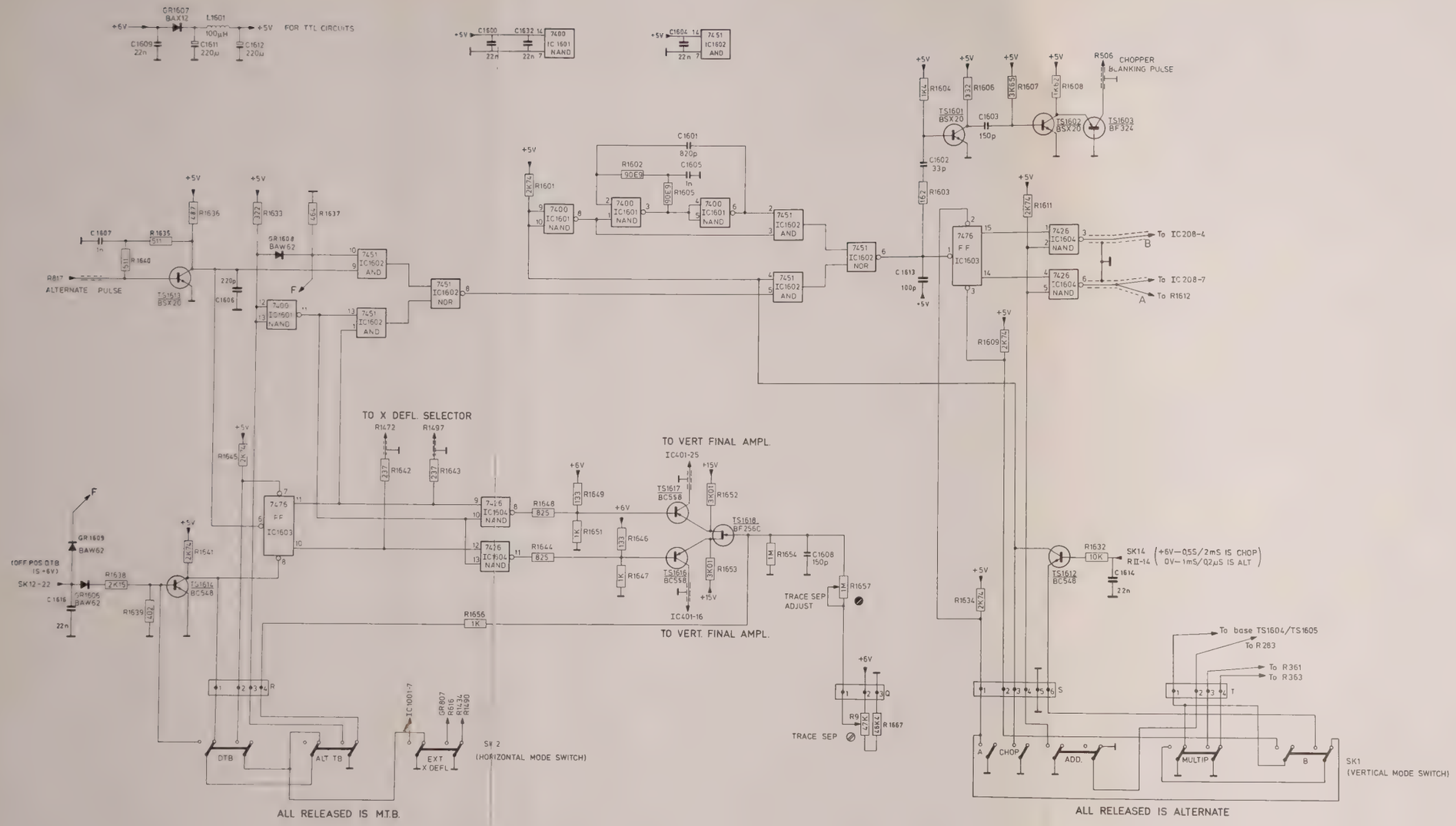
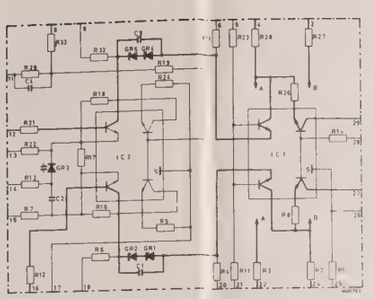


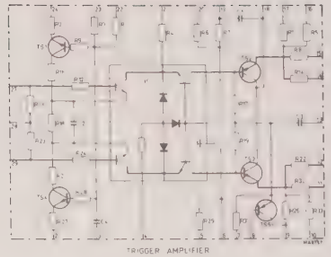
Fig. 3.27. Vertical attenuator (Assembly and print)

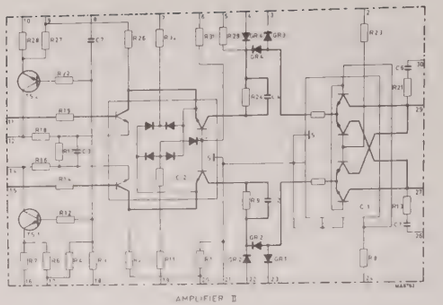


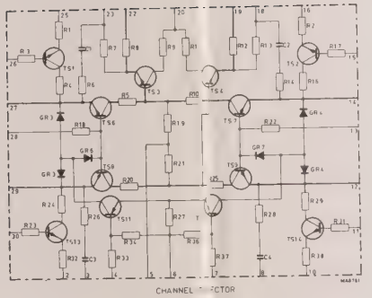
VERTICAL AND HORIZONTAL SELECTION LOGIC

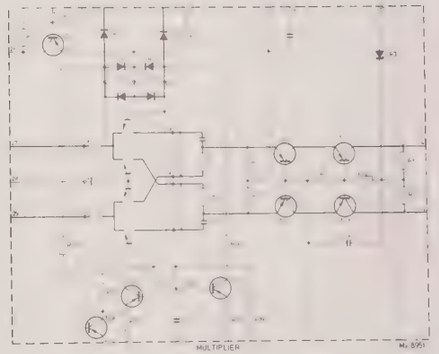
Fig. 3.28. Vertical and Horizontal selection logic

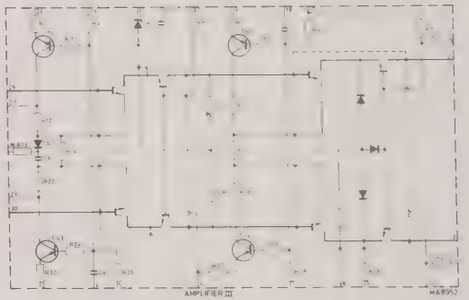












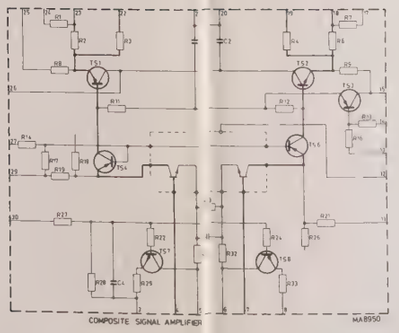
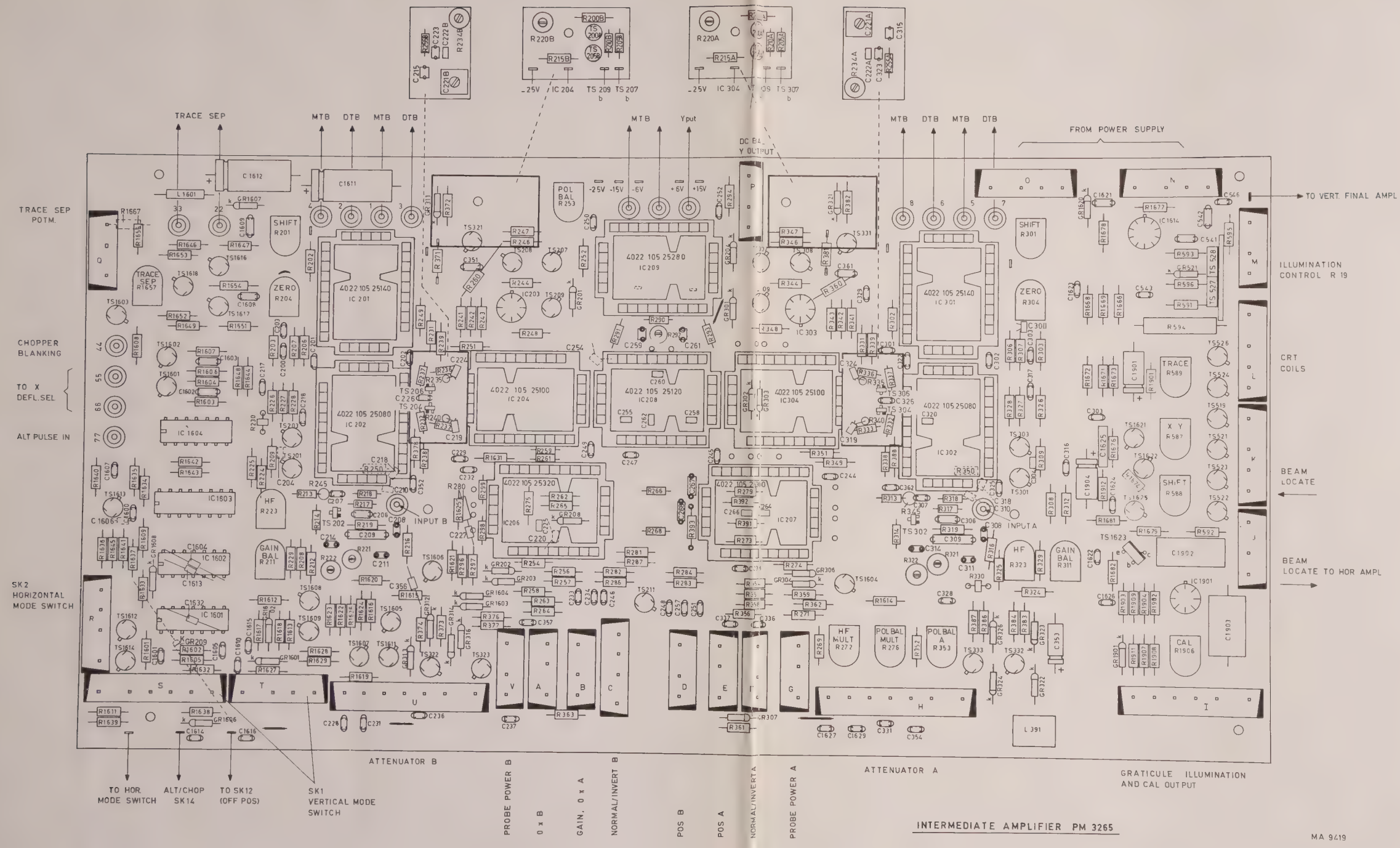


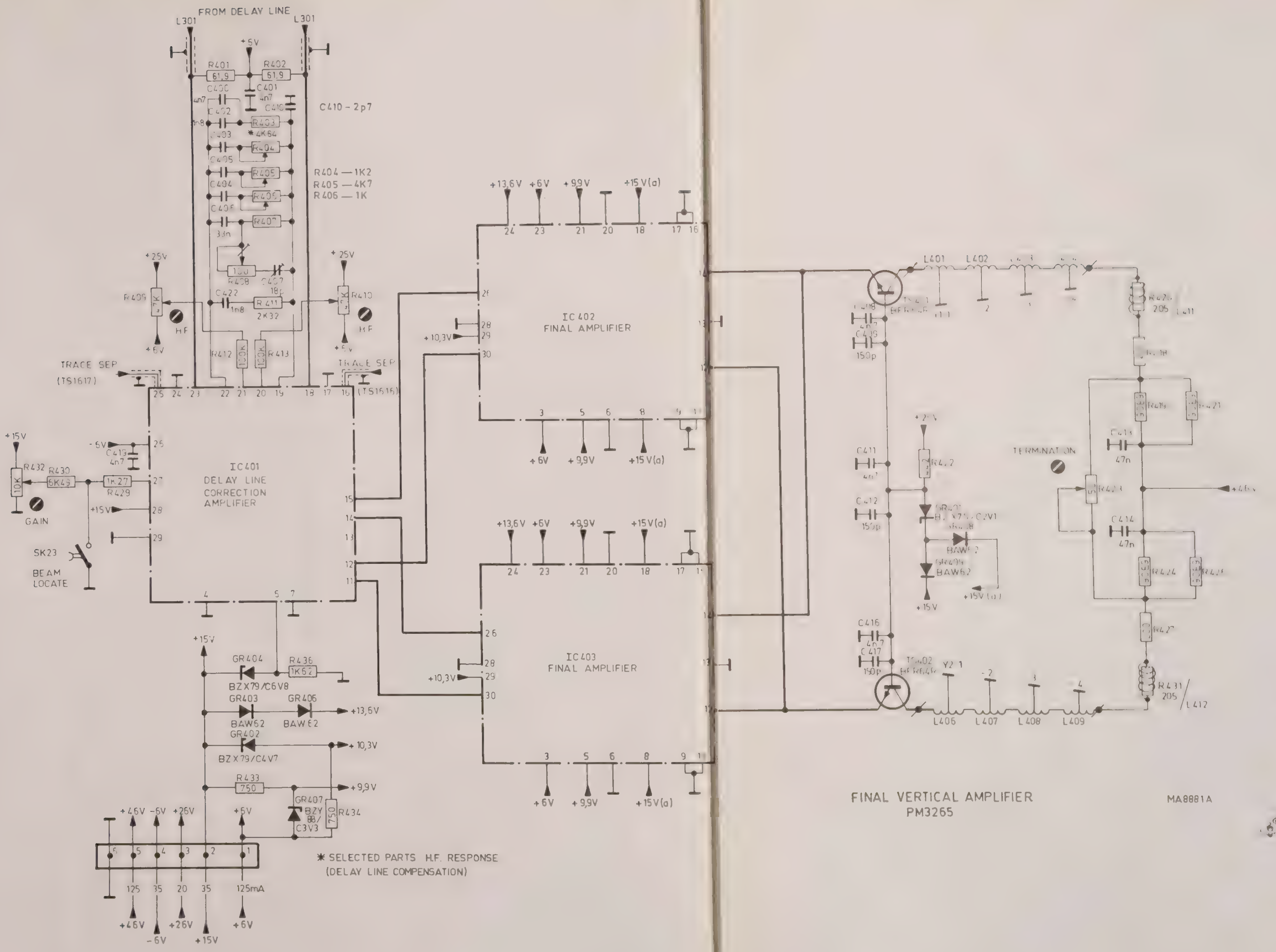
Fig. 3.29. Hybrid circuits intermediate amplifier



INTERMEDIATE AMPLIFIER PM 3265

MA 9419

Fig. 3.30. Circuit board intermediate amplifier



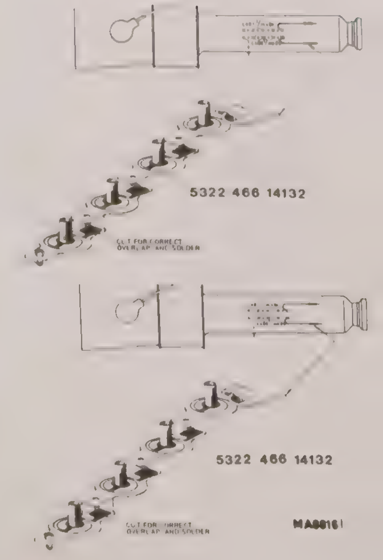


Fig. 3.32 Final Y amplifier circuit

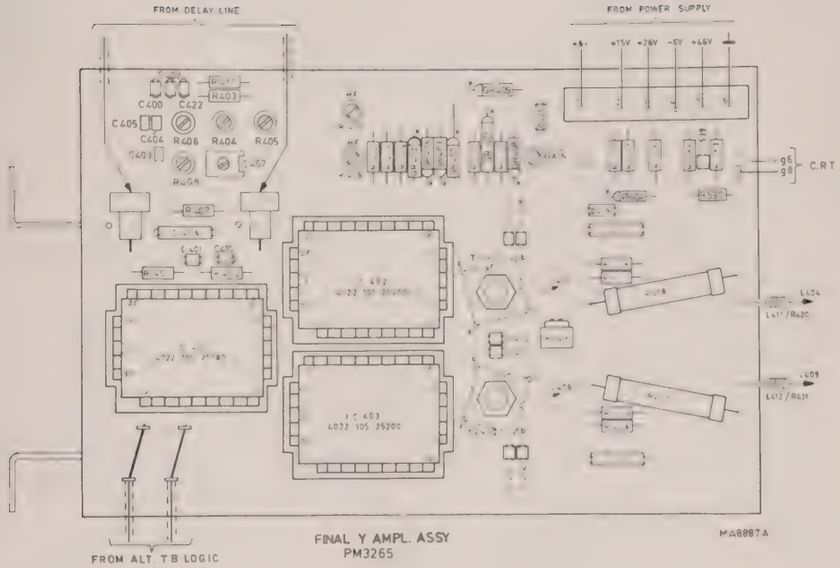


Fig. 3.33. Final Y amplifier circuit board

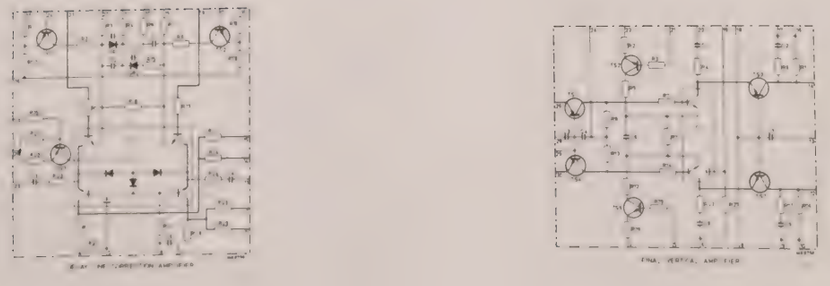


Fig. 3.34. Hybrid circuits final Y amplifier

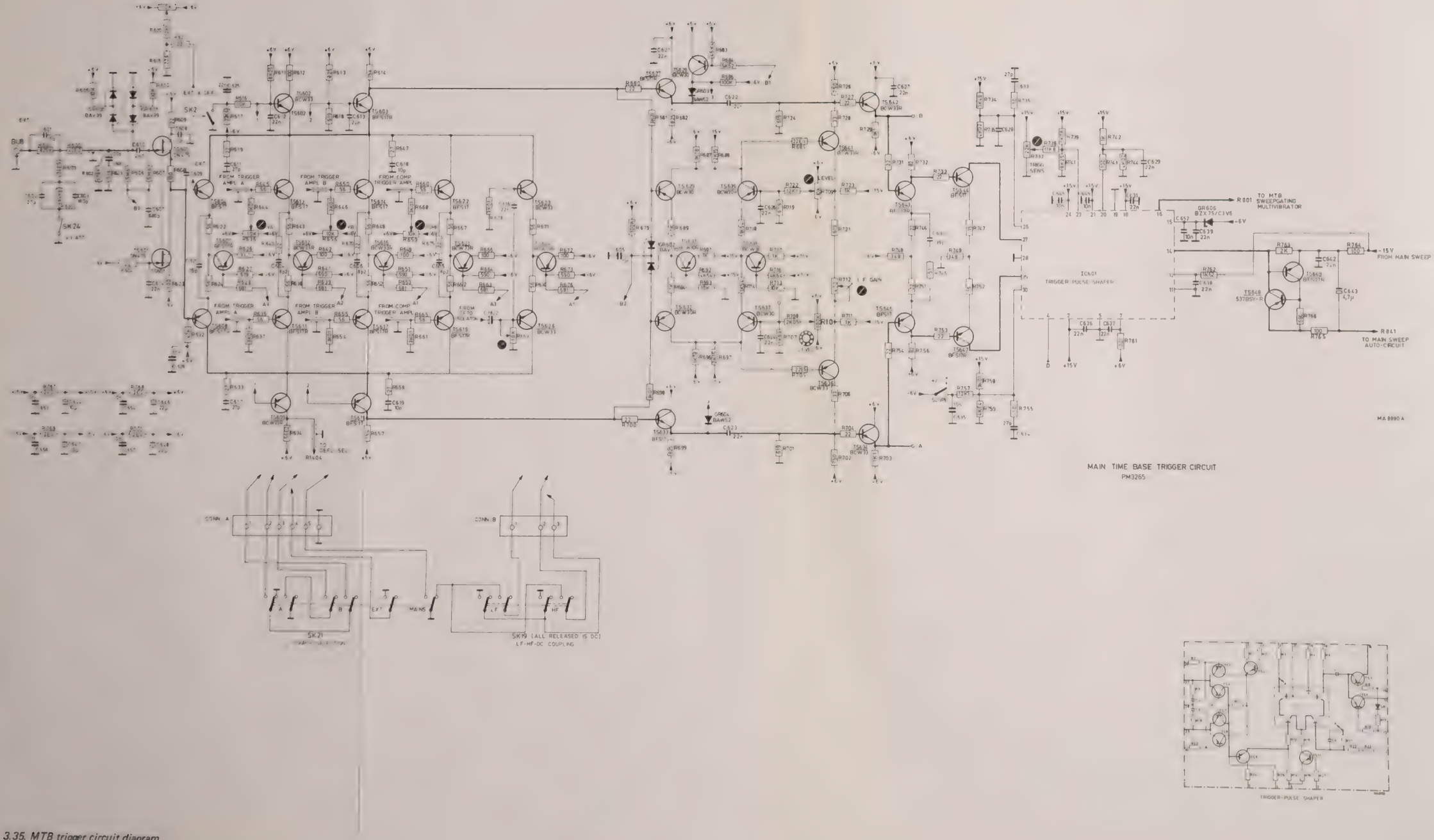


Fig. 3.35. MTB trigger circuit diagram

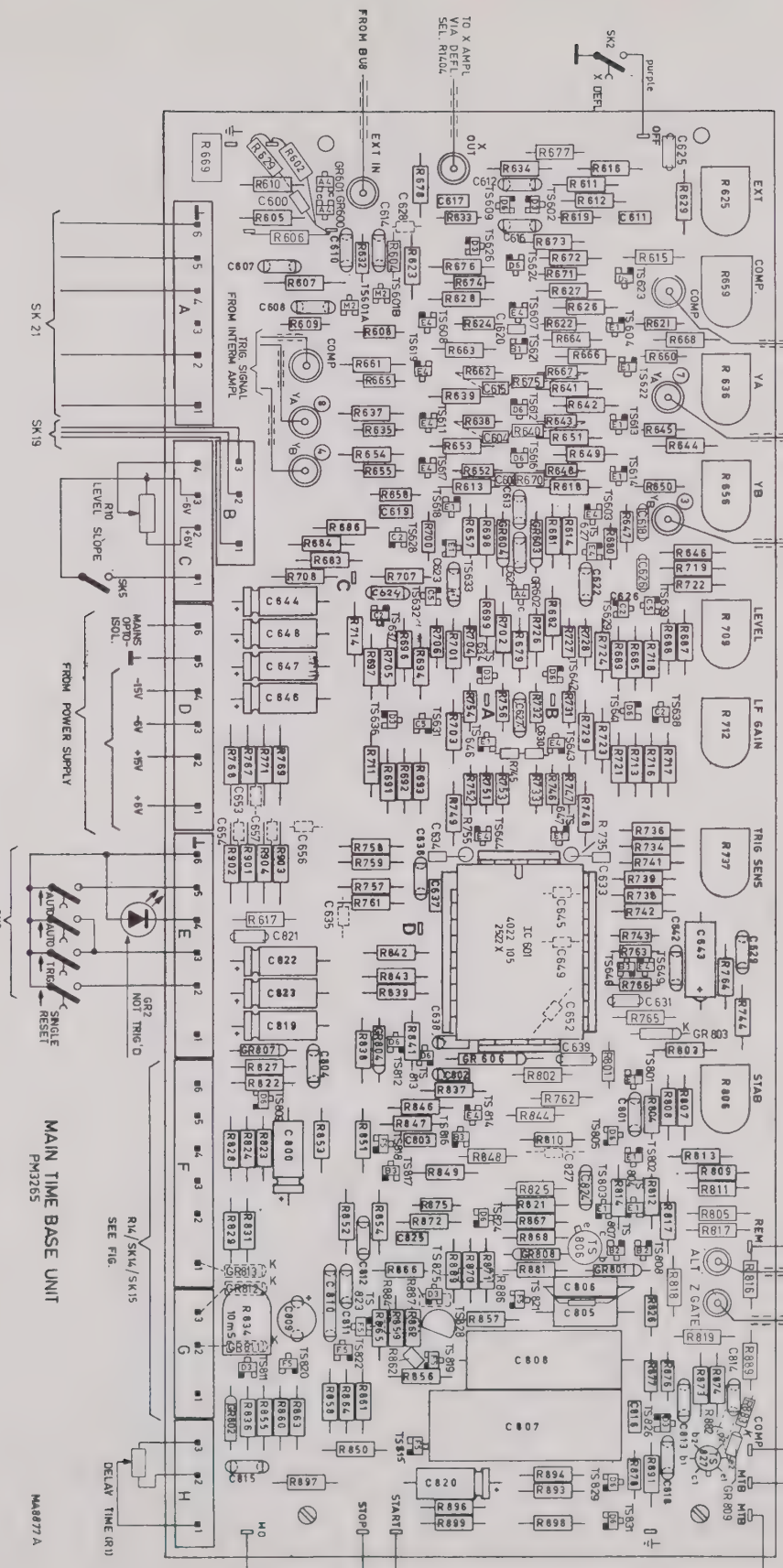


Fig. 3.36. MTB circuit board

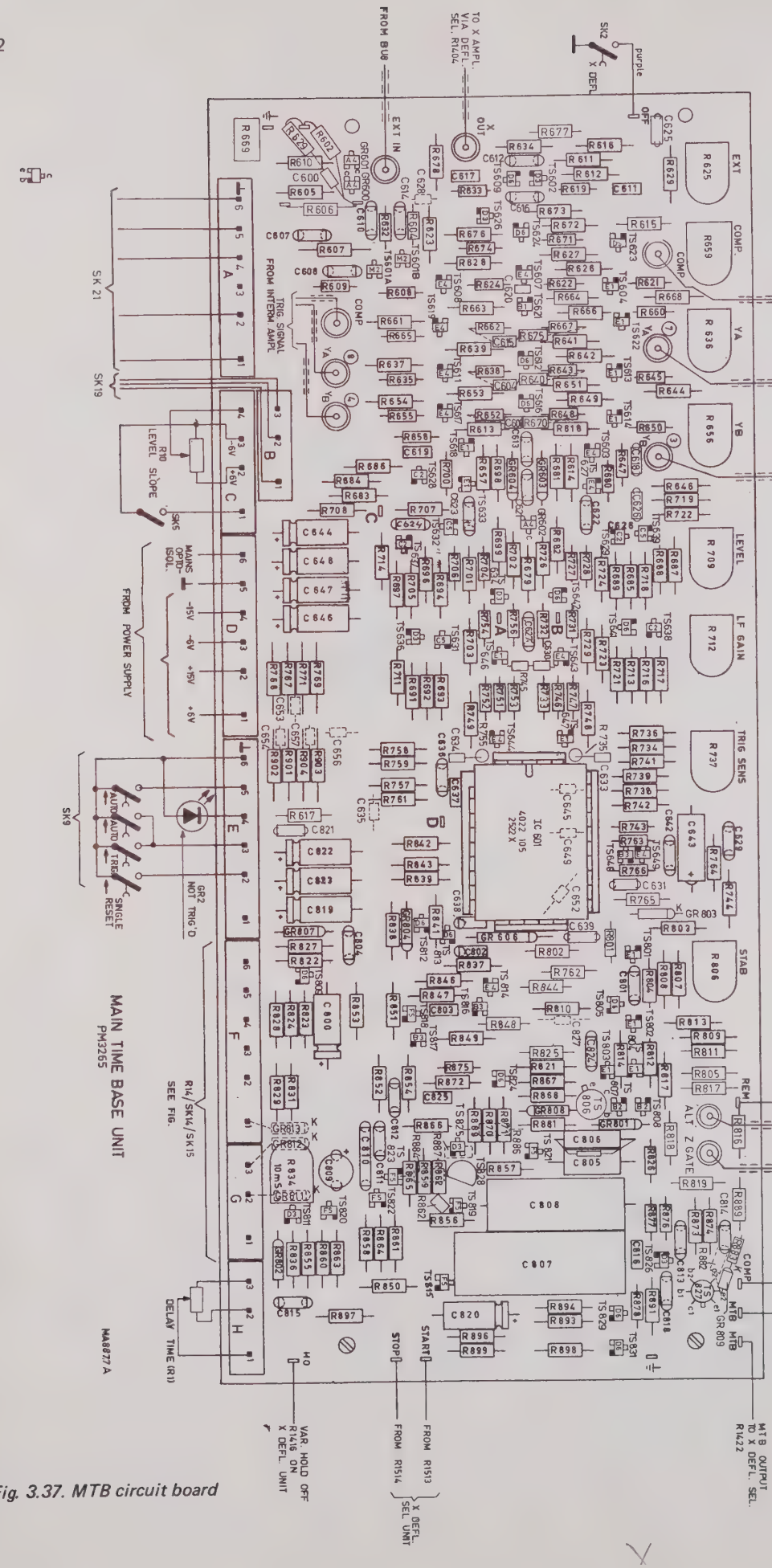


Fig. 3.37. MTB circuit board

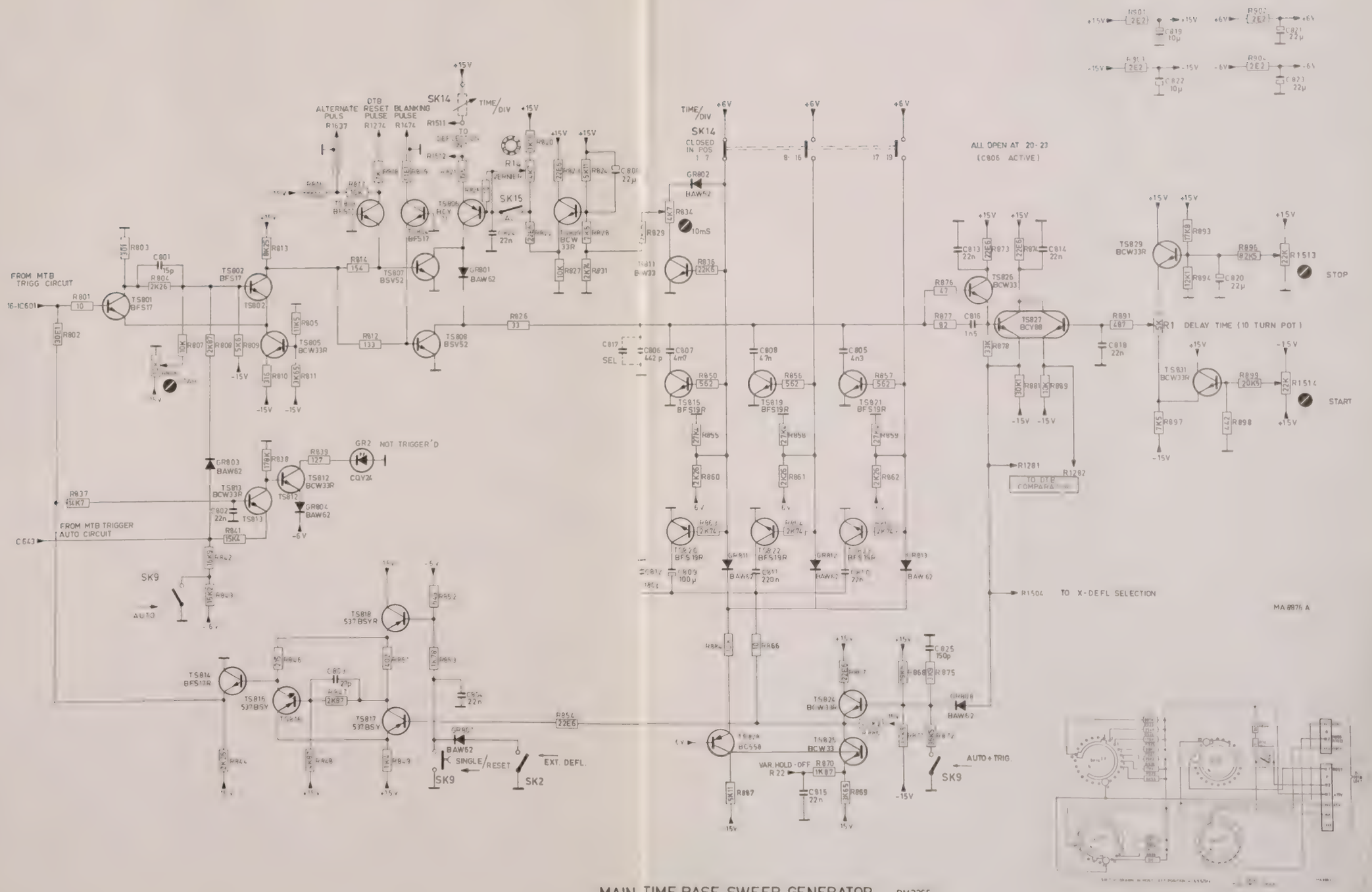


Fig. 3.38. MTB sweep circuit diagram

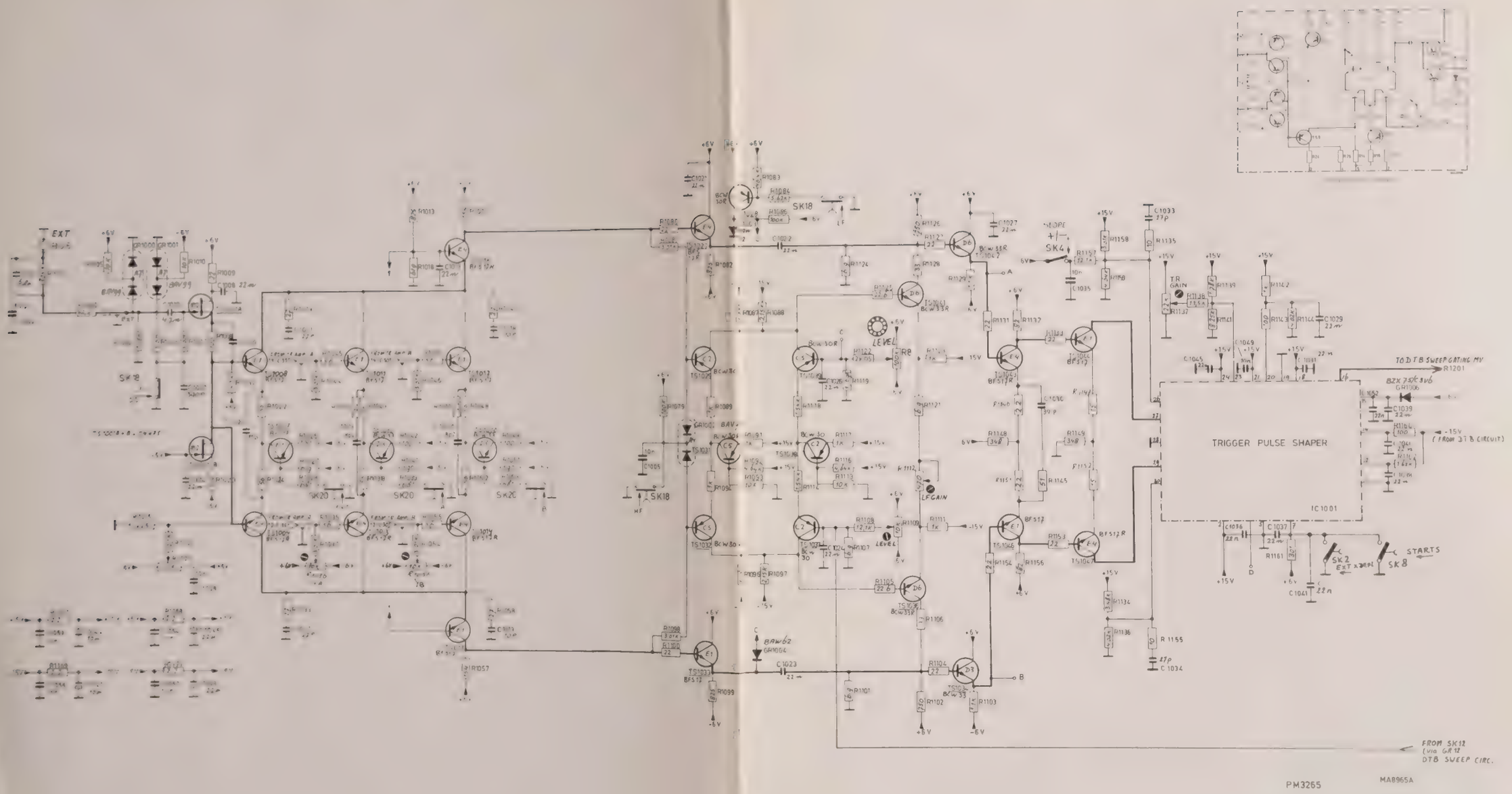


Fig. 3.39. DTB trigger circuit diagram

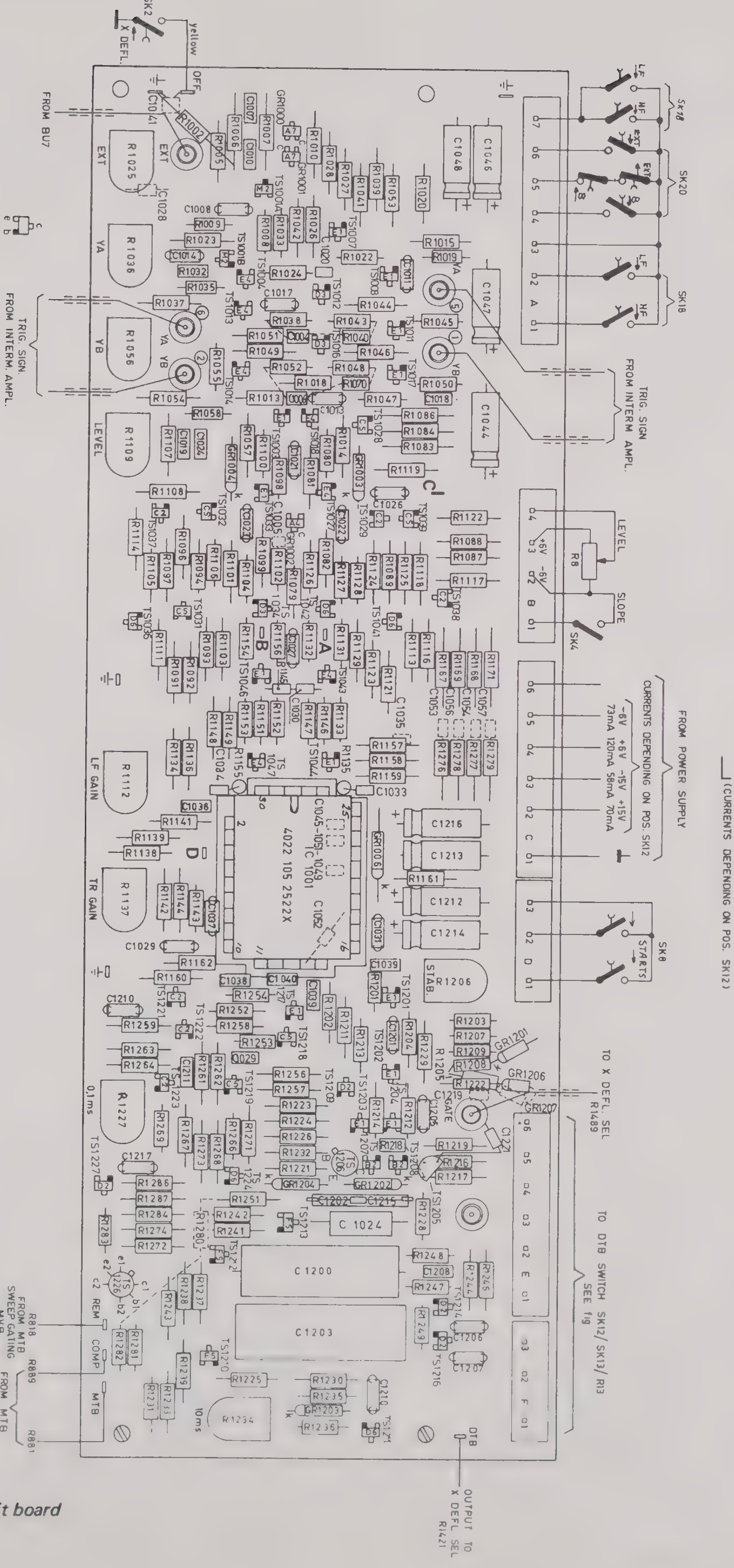

SK2
X DEFL.
yellow
OFF
FROM BU7
EXT
YA
YB
LEVEL
TRIG. SIGN.
FROM INTERM. AMPL.
LF GAIN
TR GAIN
0,1ms
10ms
REM
COMP
MTB
R818
FROM MTB
SWEEP GATING
MVB
R889
R881
FROM MTB
COMP CIRC
(TS 827)
PM 3265
MA8964A
SK18
SK20
LF
HF
EXT
B
TRIG. SIGN
FROM INTERM AMPL.
LEVEL
R8
SLOPE
SK4
+6V
-6V
FROM POWER SUPPLY
CURRENTS DEPENDING ON POS. SK12
-6V +6V -15V +15V
73mA 120mA 58mA 70mA
(CURRENTS DEPENDING ON POS. SK12)
SK8
STARTS
STAB.
TO X DEFL. SEL
R1489
GATE
TO DTB SWITCH SK12/ SK13/ R13
SEE fig
DTB
OUTPUT TO
X DEFL SEL
R1421
4022 105 2522X
IC 1001

Fig. 3.40. DTB circuit board

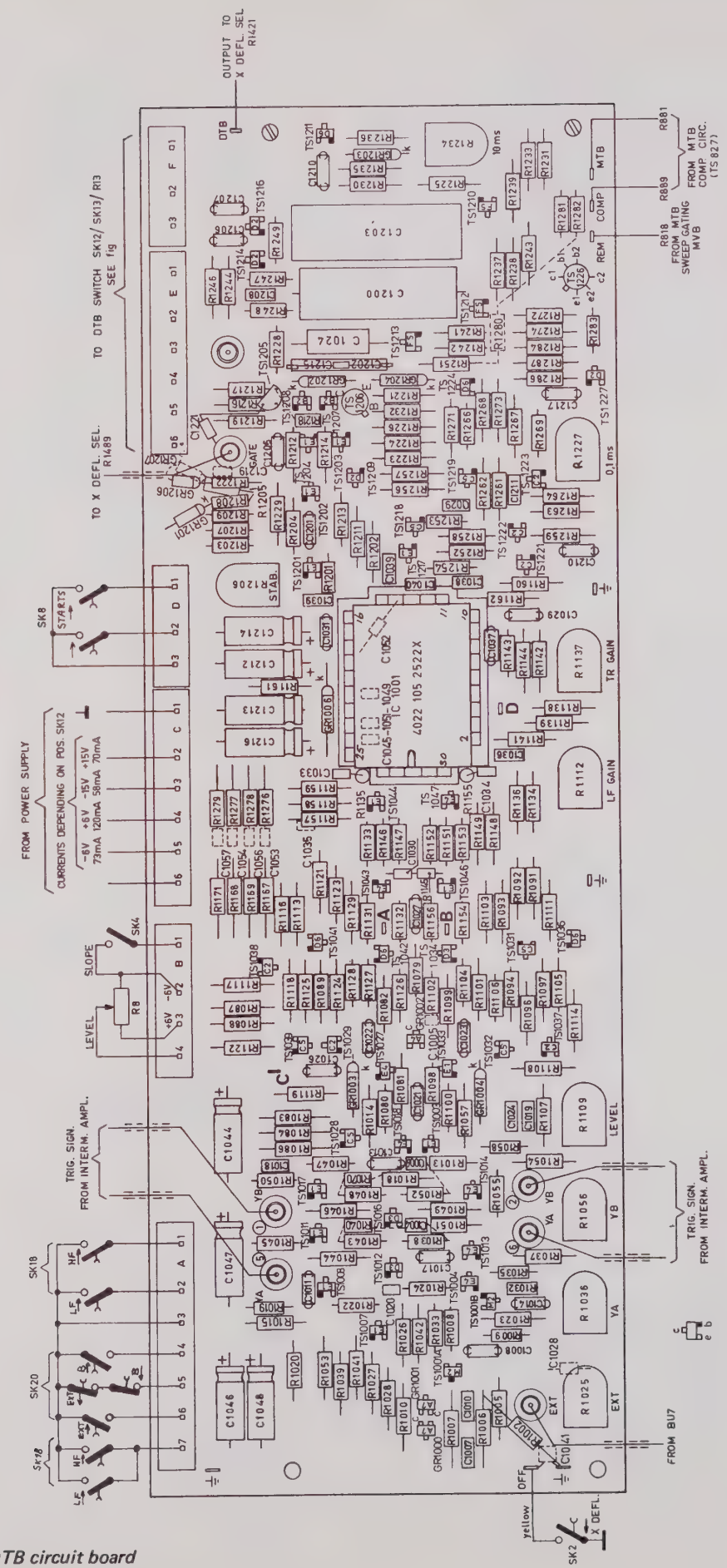


Fig. 3.41. DTB circuit board

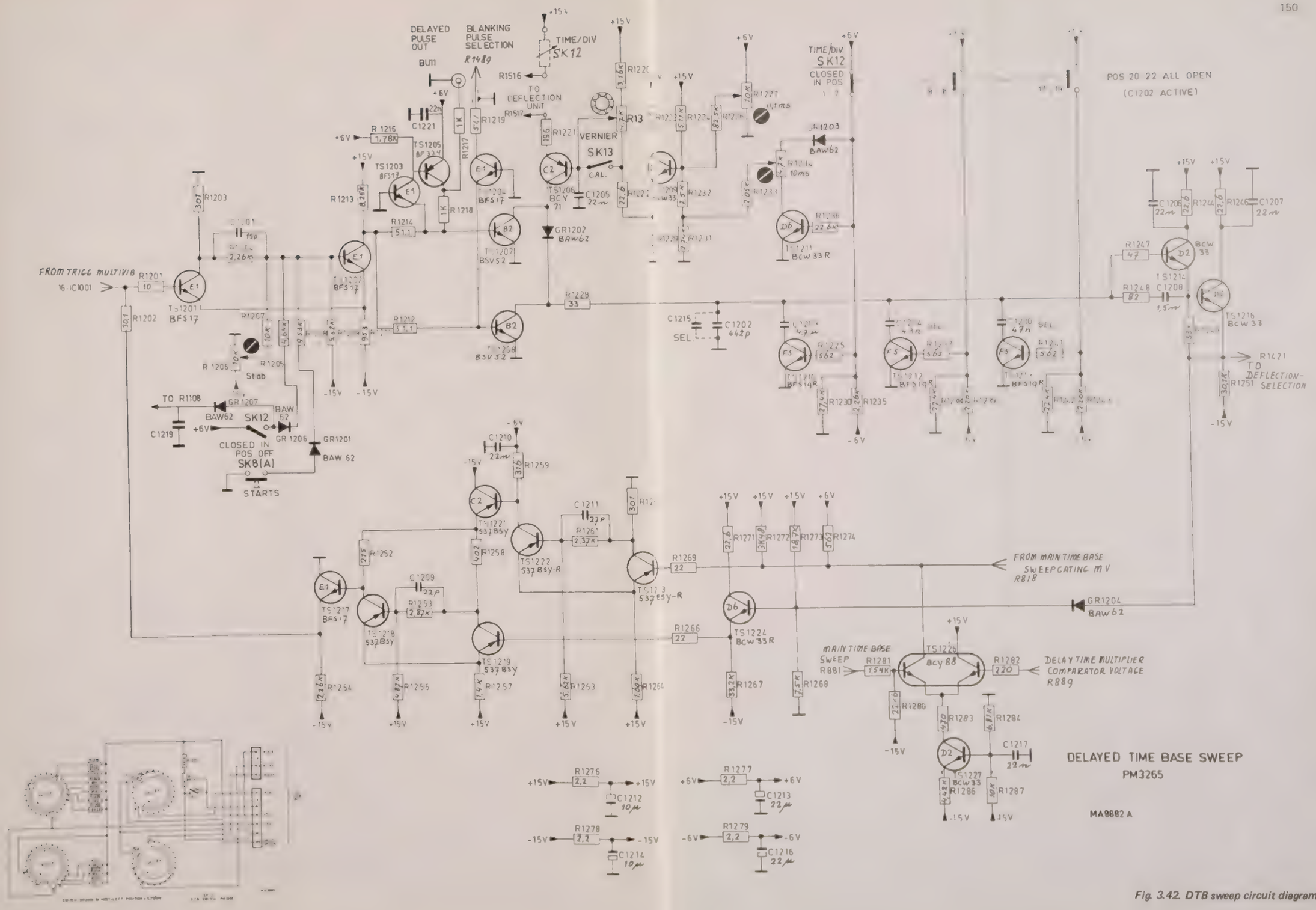


Fig. 3.42. DTB sweep circuit diagram

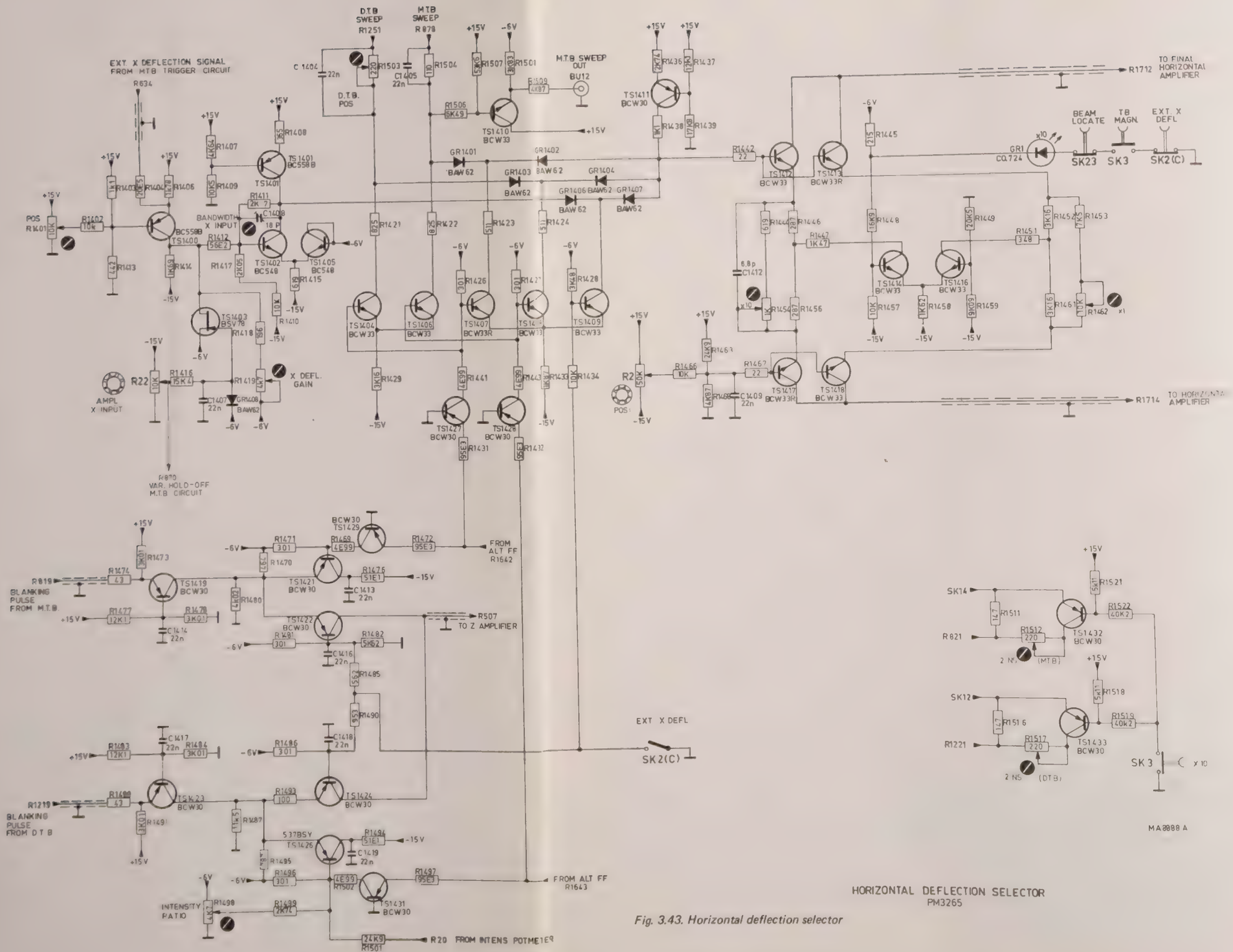


Fig. 3.43. Horizontal deflection selector

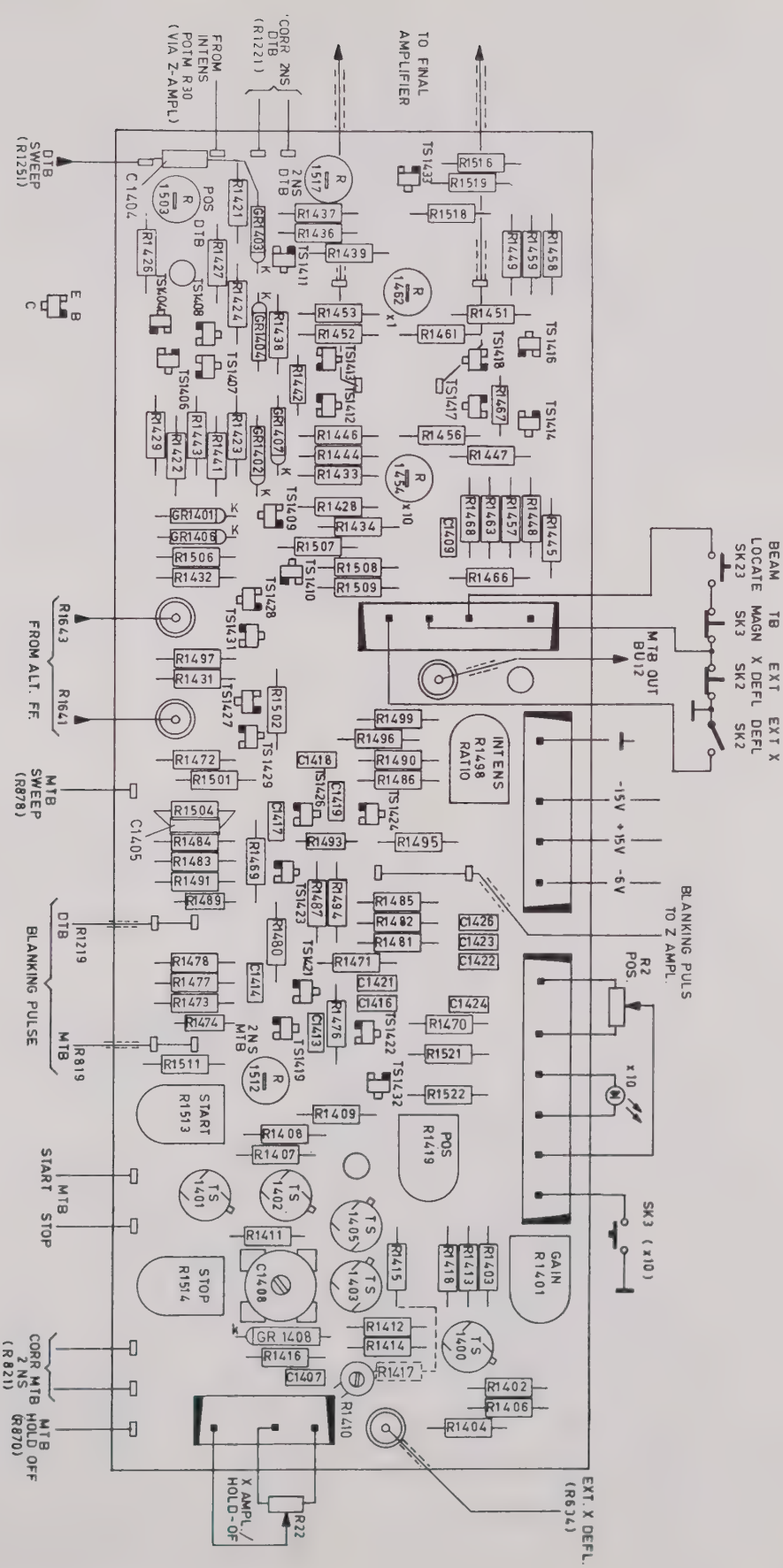


Fig. 3.44. Horizontal deflection selector circuit board

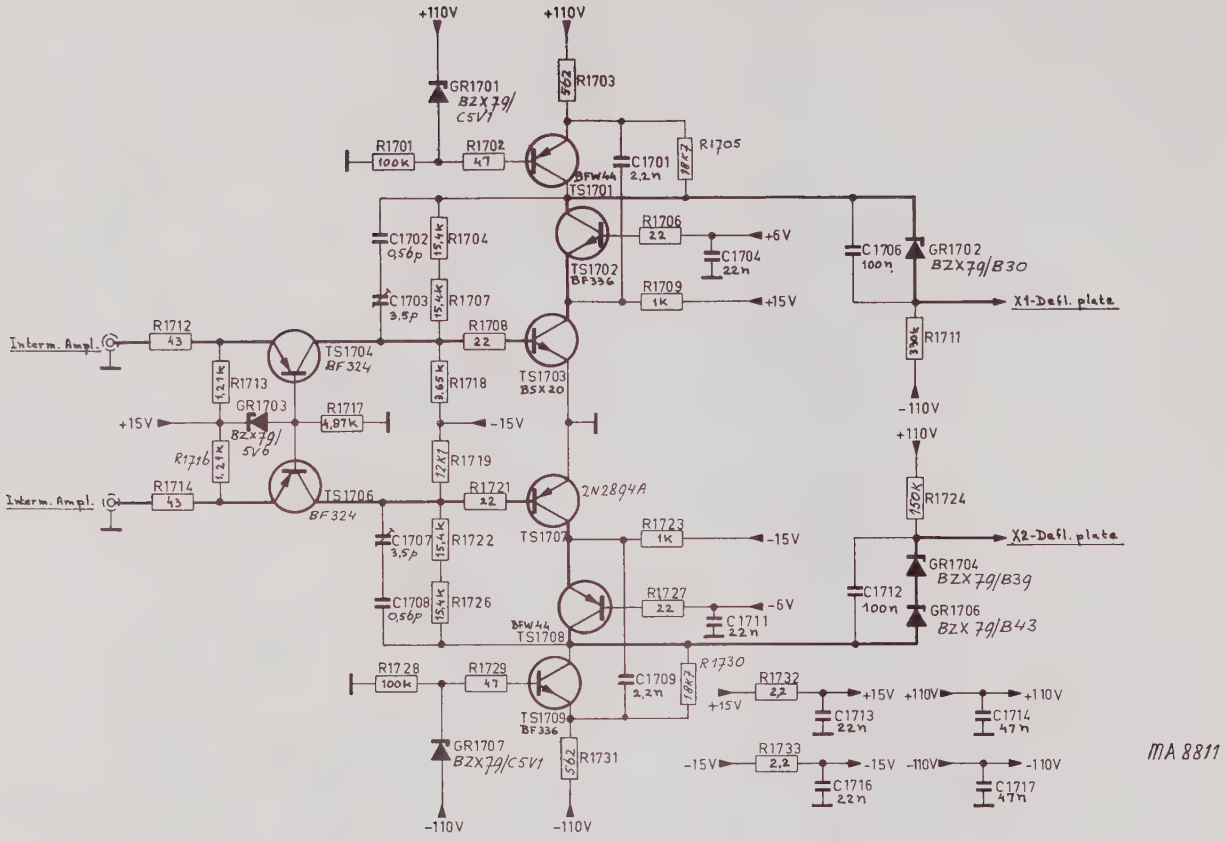


Fig. 3.45. Final X amplifier circuit diagram

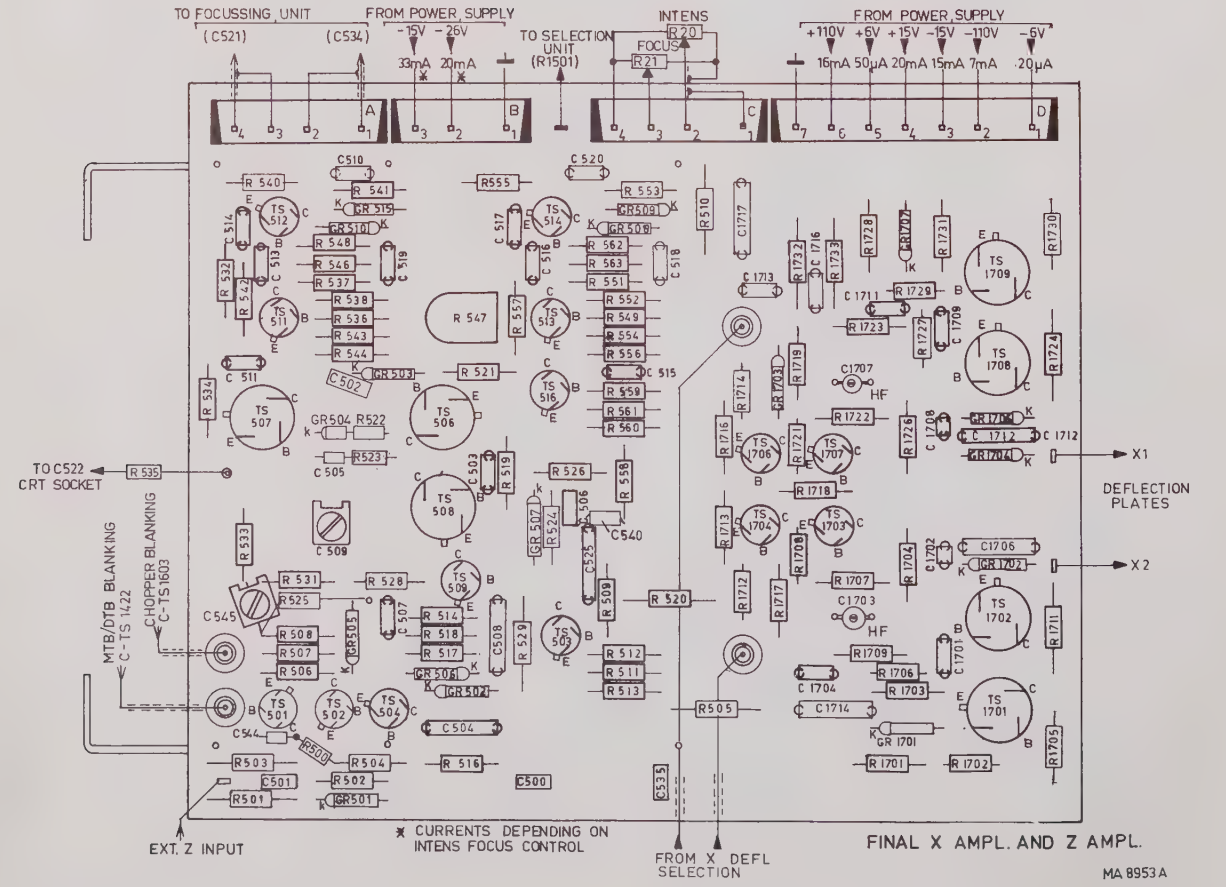


Fig. 3.46. Final X and Z amplifier board

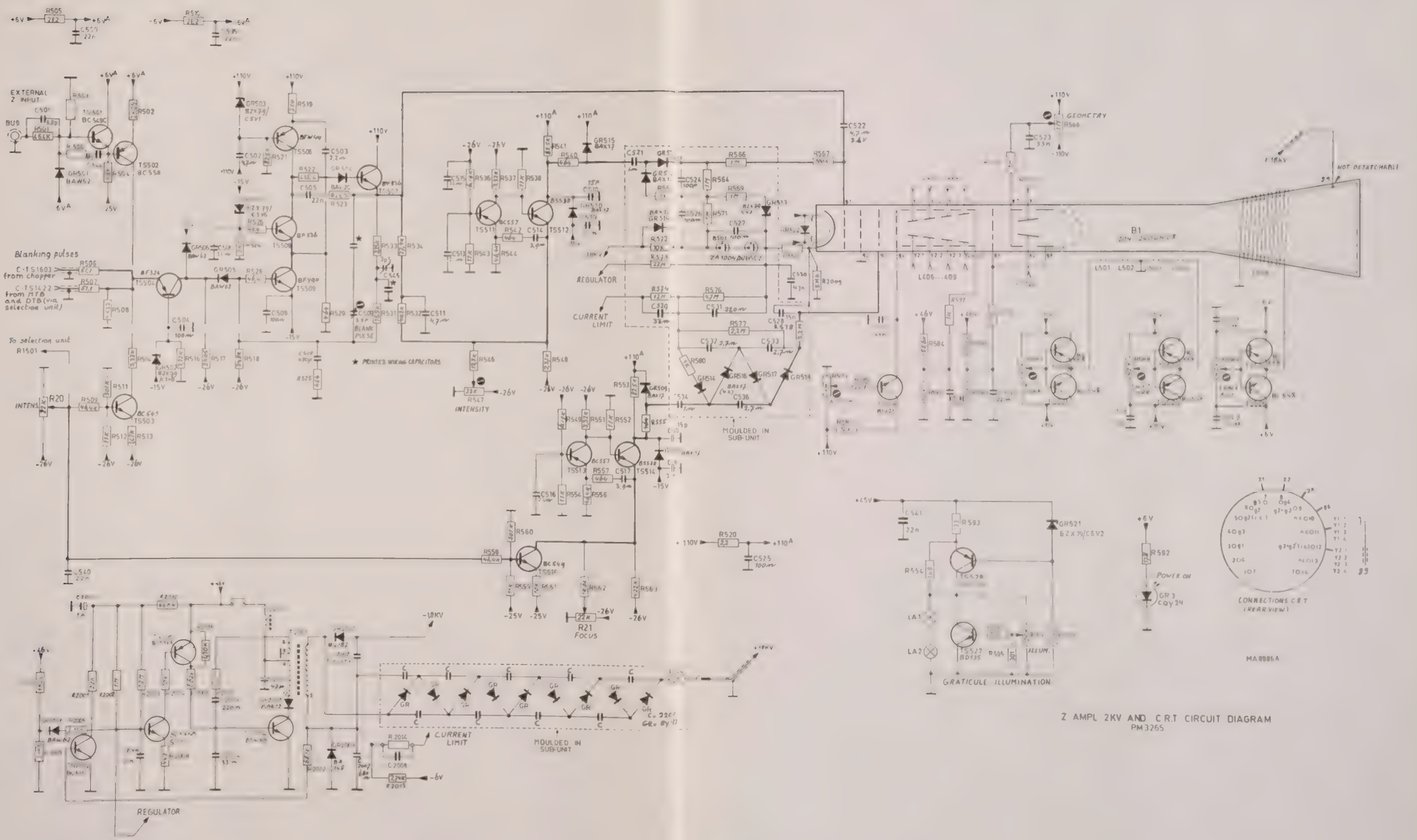


Fig. 3.47. Z amplifier, 2 kV and CRT circuit diagram

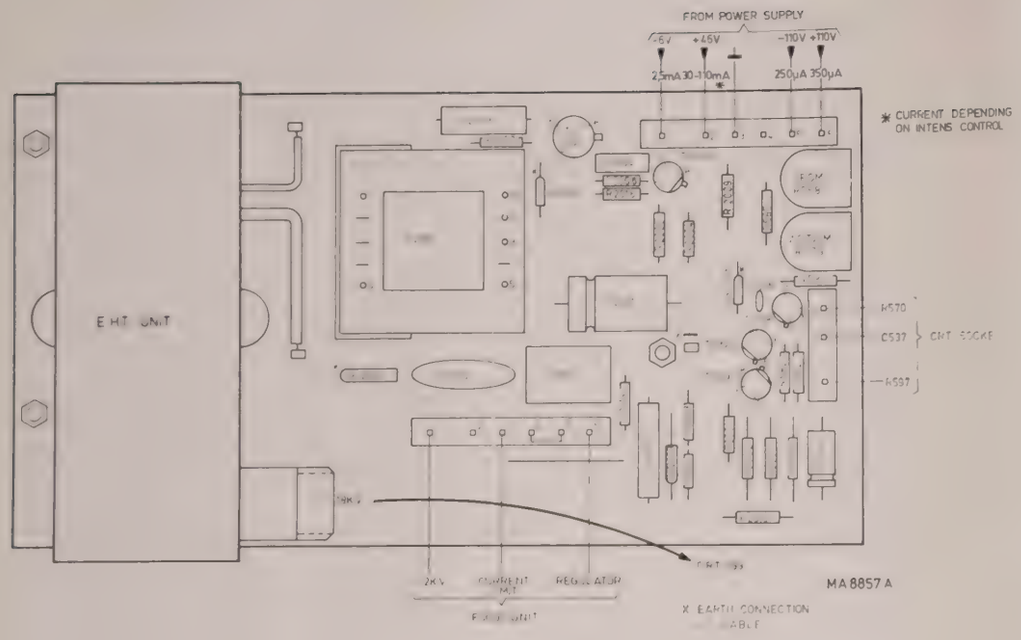


Fig. 3.48. 2 kV unit

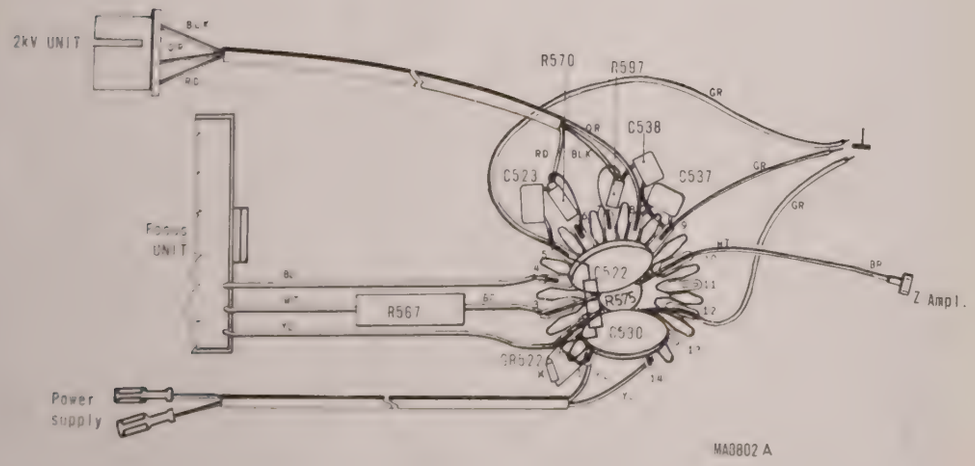


Fig. 3.49. CRT socket assembly

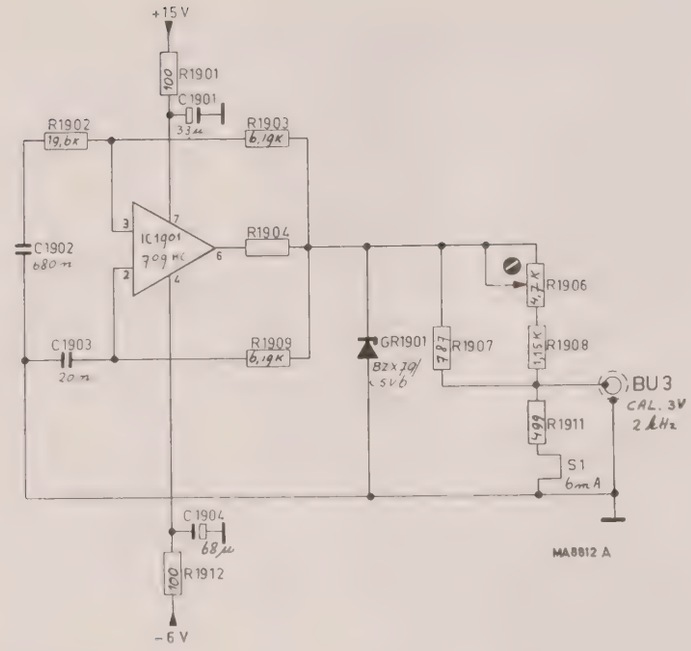


Fig. 3.50. Calibration circuit diagram

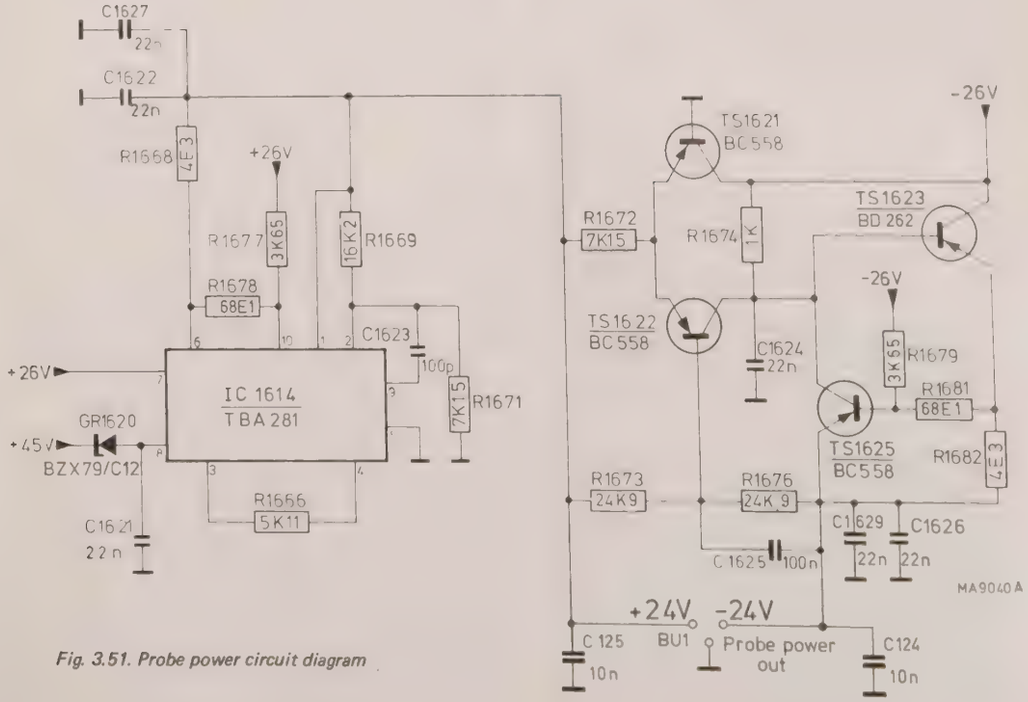


Fig. 3.51. Probe power circuit diagram

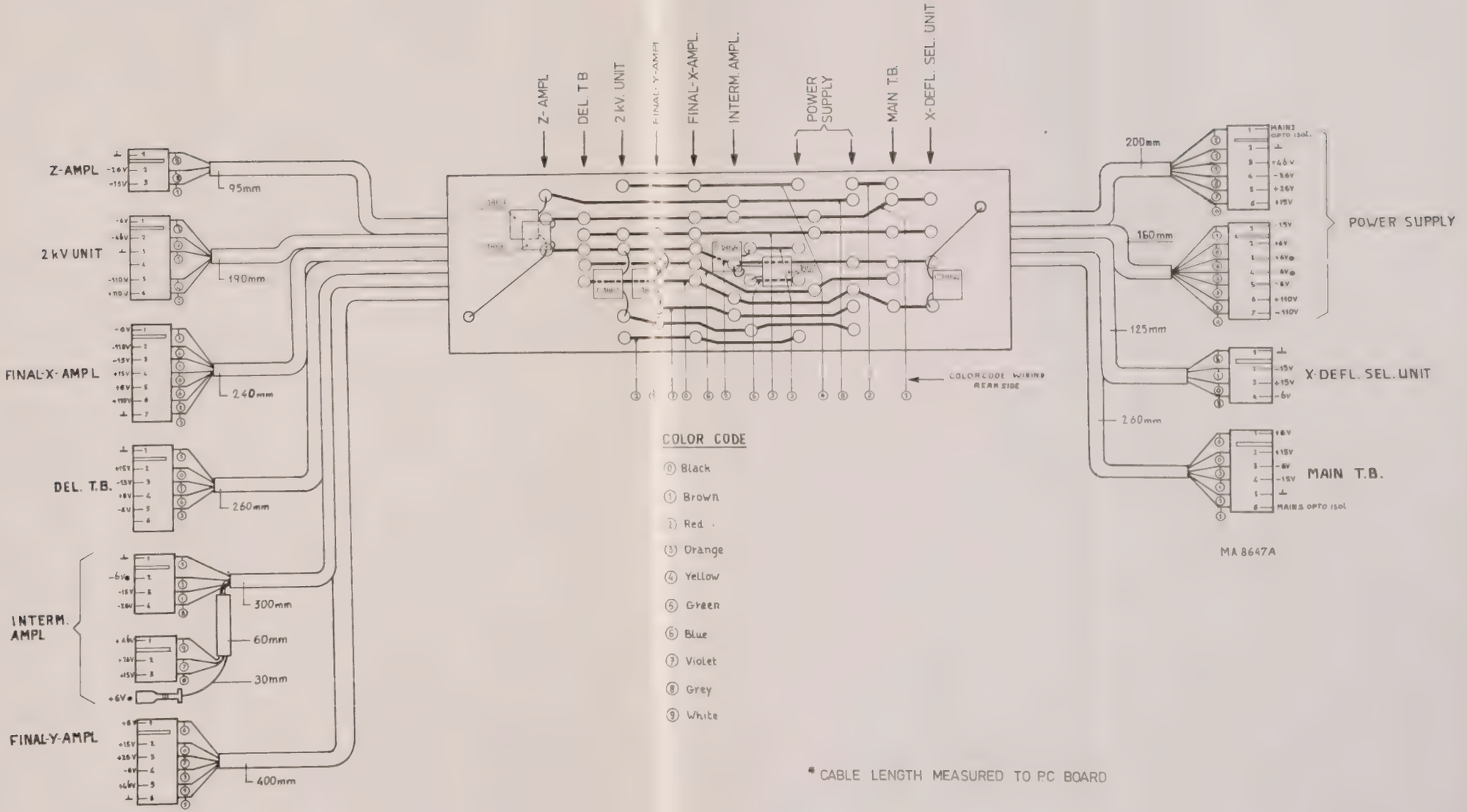


Fig. 3.52. Power distribution

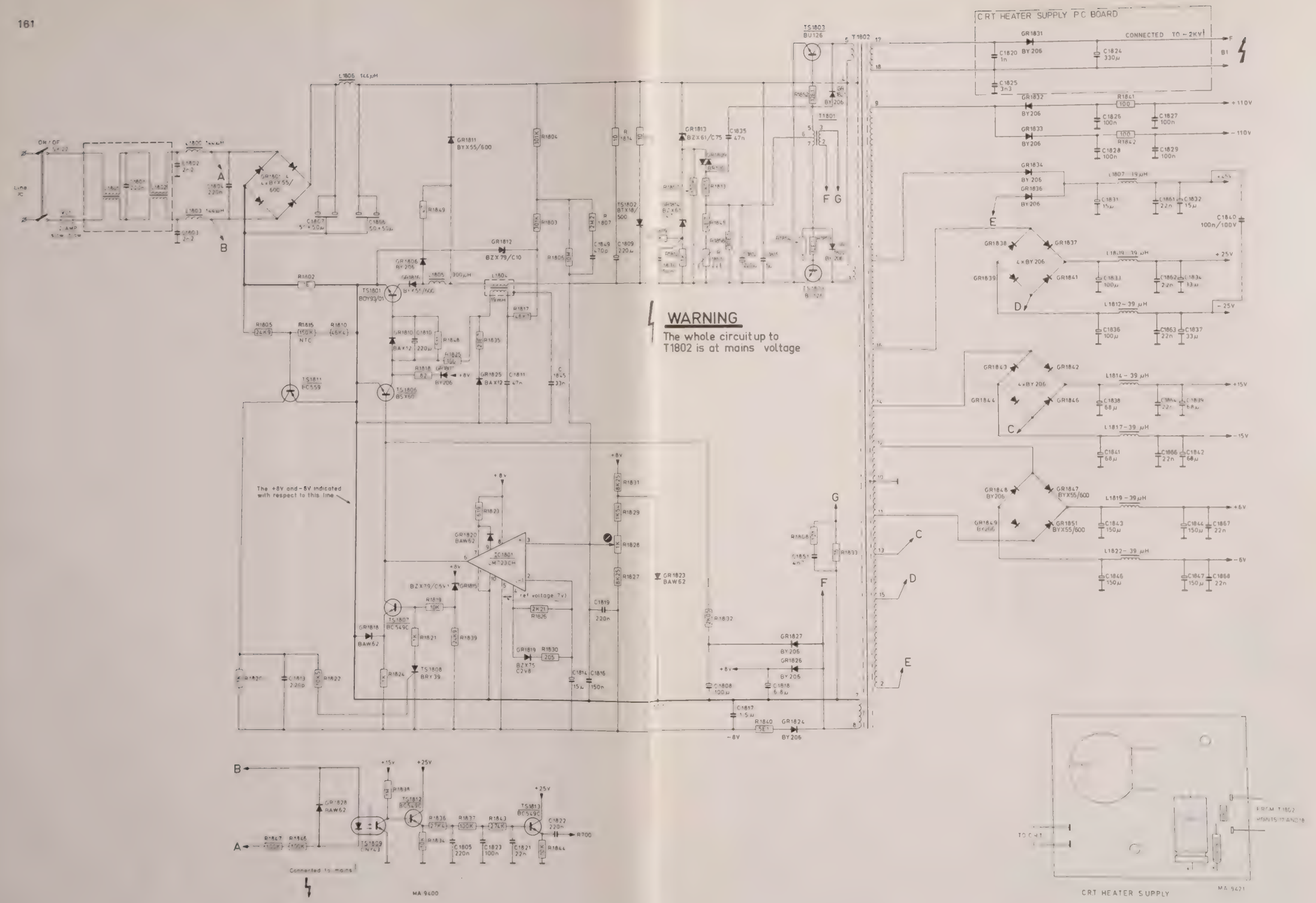


Fig. 3.53. Power supply circuit diagram

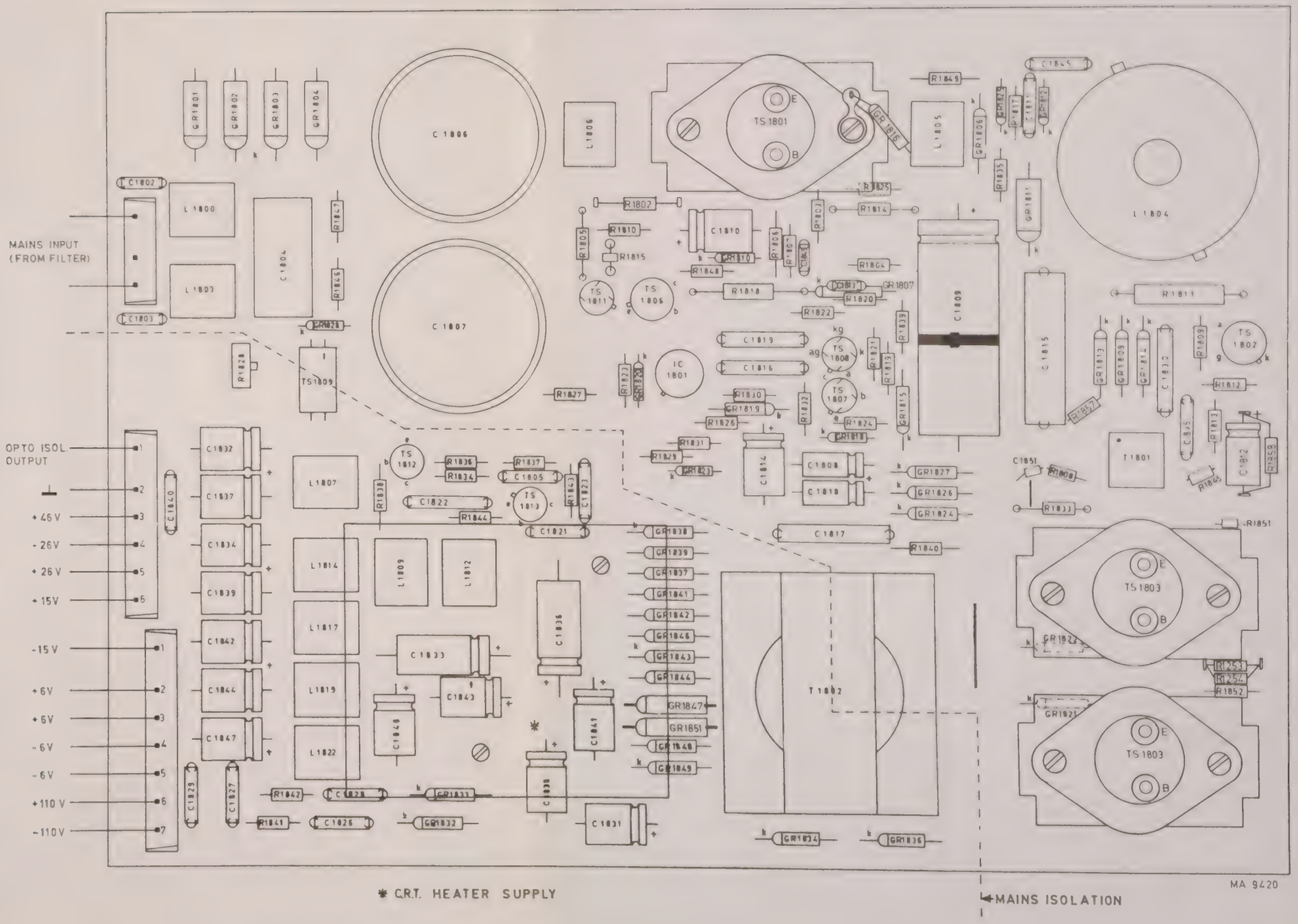


Fig. 3.54. Power supply circuit board

3.7. PARTS LIST AND DIAGRAMS

(Subject to alterations without notice)

3.7.1. Mechanical parts

Text plate is deleted

3.7.2. Electrical parts

Added:

R9032	Select-in-test resistor			MR25	Mtl. flm. rst.
R9033	Select-in-test resistor			MR25	Mtl. flm. rst.
R9034	Select-in-test resistor			MR25	Mtl. flm. rst.
R9036	Select-in-test resistor			MR25	Mtl. flm. rst.
R9037	4822 111 30325	150 Ω	5 %	CR16	Carb. rst.
R9038	4822 111 30325	150 Ω	5 %	CR16	Carb. rst.
R9039	5322 116 50664	2,05 kΩ	1 %	MR25	Mtl. flm. rst.
R9041	5322 116 54694	90,9 kΩ	1 %	MR25	Mtl. flm. rst.
R9042	5322 116 54694	90,9 kΩ	1 %	MR25	Mtl. flm. rst.
R9043	4822 111 30122	3,6 kΩ	5 %	CR16	Carb. rst.
R9044	4822 111 30122	3,6 kΩ	5 %	CR16	Carb. rst.
R9047	Select-in-rest resistor			MR25	Mtl. flm. rst.
R9048	5322 116 54606	7,15 kΩ	1 %	MR25	Mtl. flm. rst.
R9049	5322 116 50635	1,47 kΩ	1 %	MR25	Mtl. flm. rst.
R9051	5322 116 30079	1,5 kΩ	20 %		N.t.c. rst.
GR9031	5322 130 30613	BAW62			Diode
GR9032	5322 130 30613	BAW62			Diode
GR9008	5322 130 30613	BAW62			Diode
GR9009	5322 130 30613	BAW62			Diode

Changed value:

C630	4822 122 31049	6,8 pF	0,25 pF	100 V	Cer. cap.
R626	5322 116 54469	100 Ω	1 %	MR25	Mtl. flm. rst.
R707	5322 116 50586	3,01 kΩ	1 %	MR25	Mtl. flm. rst.
R732	5322 111 30359	1,3 kΩ	5 %	CR16	Carb. rst.
R745	4822 111 30439	20 Ω	5 %	CR16	Carb. rst.
R746	4822 111 30325	150 Ω	5 %	CR16	Carb. rst.
R748	5322 116 54499	249 Ω	1 %	MR25	Mtl. flm. rst.
R751	4822 111 30325	150 Ω	5 %	CR16	Carb. rst.
R756	4822 111 30359	1,3 kΩ	5 %	CR16	Carb. rst.

Parts on Ext. Input board

C2501	4822 122 31195	10 pF	2 %	500 V	Cer. cap.
C2502	4822 121 40349	22 nF	10 %	400 V	Flat film. cap.
C2503	5322 125 50051	18 pF		300 V	Trimmer cap.
C2504	4822 122 31074	56 pF	2 %	100 V	Cer. cap.
C2506	4822 122 30103	22 nF	−20/+80 %	40 V	Cer. cap.
C2507	4822 122 31172	180 pF	10 %	100 V	Cer. cap.
C2508	4822 122 30103	22 nF	−20/+80 %	40 V	Cer. cap.
C2509	4822 122 31195	10 pF	2 %	500 V	Cer. cap.
R2501	5322 116 54335	750 kΩ	1 %	MR30	Mtl. film. rst.
R2502	5322 116 54549	1 kΩ	1 %	MR25	Mtl. film. rst.
R2503	5322 116 54549	1 kΩ	1 %	MR25	Mtl. film. rst.
R2504	5322 116 54742	249 kΩ	1 %	MR25	Mtl. film. rst.
R2508	4822 111 30333	1 MΩ	10 %	CR16	Carb. rst.
R2509	5322 116 54442	51,1 Ω	1 %	MR25	Mtl. film. rst.
R2511	5322 116 54655	30,1 kΩ	1 %	MR25	Mtl. film. rst.
R2512	5322 116 50621	538 Ω	1 %	MR25	Mtl. film. rst.
R2513	5322 116 50672	51,1 kΩ	1 %	MR25	Mtl. film. rst.
R2514	5322 116 54549	1 kΩ	1 %	MR25	Mtl. film. rst.
R2516	5322 116 51052	42,2 Ω	1 %	MR25	Mtl. film. rst.
R2517	5322 116 54549	1 kΩ	1 %	MR25	Mtl. film. rst.
TS2501	5322 130 44216	BC549C			Transistor
TS2502	5322 130 44216	BC549C			Transistor
TS2503	5322 130 44617	BC558C			Transistor

3.8. MODEL PM 3265E

The PM 3265E Portable Dual-trace Oscilloscope is an instrument based upon the PM 3265 Portable Dual-trace Multiplier Oscilloscope. The main difference is the absence of multiplier, probe power, beam finder, composite triggering and additional inputs and outputs in the PM 3265E.

The Instruction Manual of the PM 3265 applies also to the PM 3265E, if the following differences are taken into account.

In chapter 1.2. Characteristics:

1.2.2.10. "Display modes": The specifications concerning the multiplier must be deleted.
Sections 1.2.2.14. ... 1.2.2.26. must be deleted.
1.2.3.1. The XY mode "Composite A and B signal" must be deleted.
1.2.7.1. Source "Internal composite signal from both channel A and B" must be deleted.
Section 1.2.10. "Additional inputs and outputs" must be deleted.
1.2.11.3. "Probe power" must be deleted.
1.2.11.4. "Power consumption": The power consumption is 47 W.

Chapter 1.3. "Glossary of multiplier terms" must be deleted.

Chapter 2.2. "Operating instructions" and following chapters:
All sections concerning multiplier, probe power, composite triggering, beam locate and additional input and output circuits, must be deleted.

Chapter 3.7. "Parts lists"; different for the PM 3265E are:

Text plate	5322 455 84056
Text strip for handle	5322 455 84057
Rear cover	5322 447 94148
Attenuator without probe power socket	5322 218 64059
Intermediate Y amplifier	5322 216 54149

Some other parts have changed as well, but for economy reasons we have standardized on PM 3265 parts that can also be used for the PM 3265E. This concerns mainly complete units. All components concerning multiplier, probe power, additional circuits, composite triggering and additional inputs and outputs are not applicable to the PM 3265E.

Fig. 3.55. PM 3265E

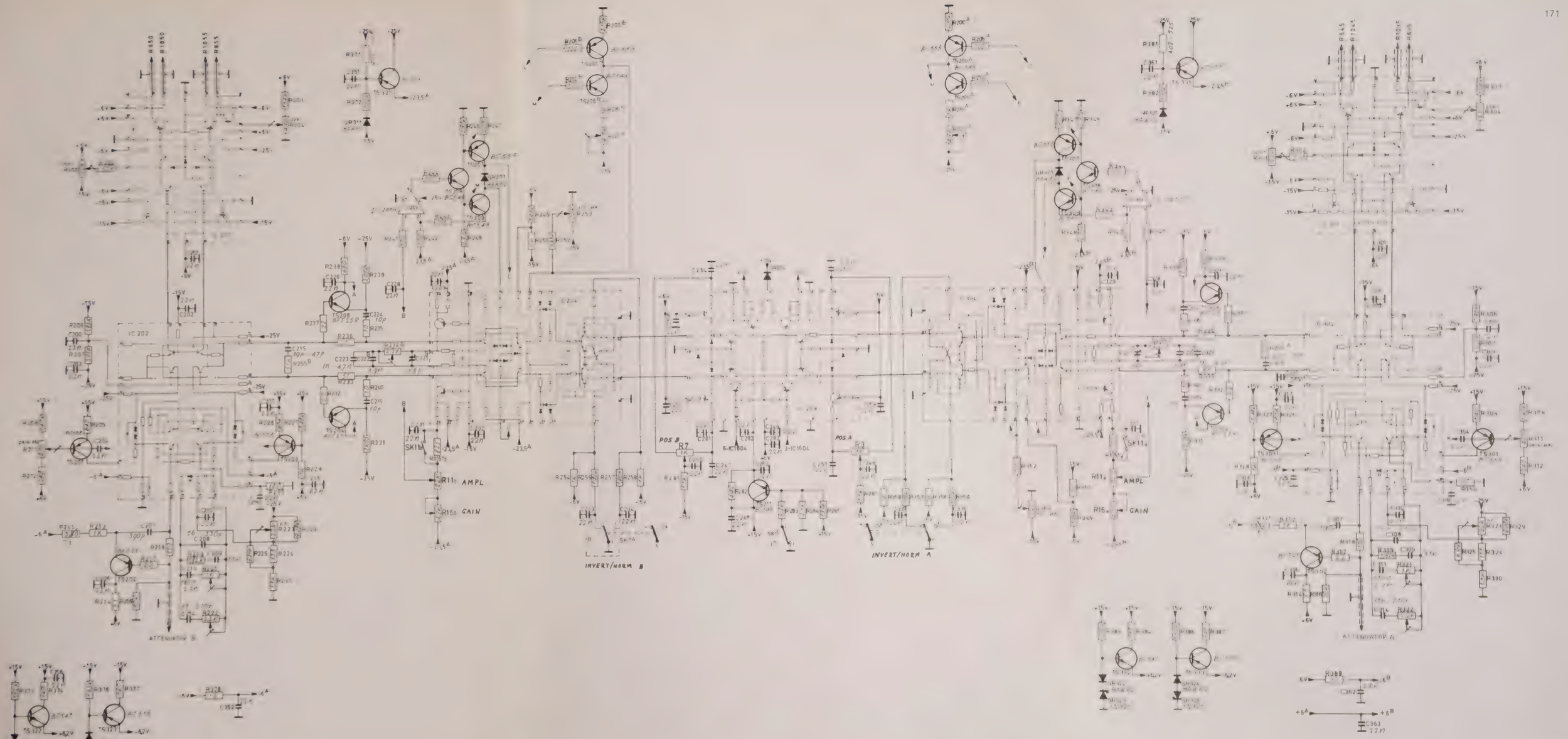


Fig. 3.56. Intermediate amplifier PM 3265E

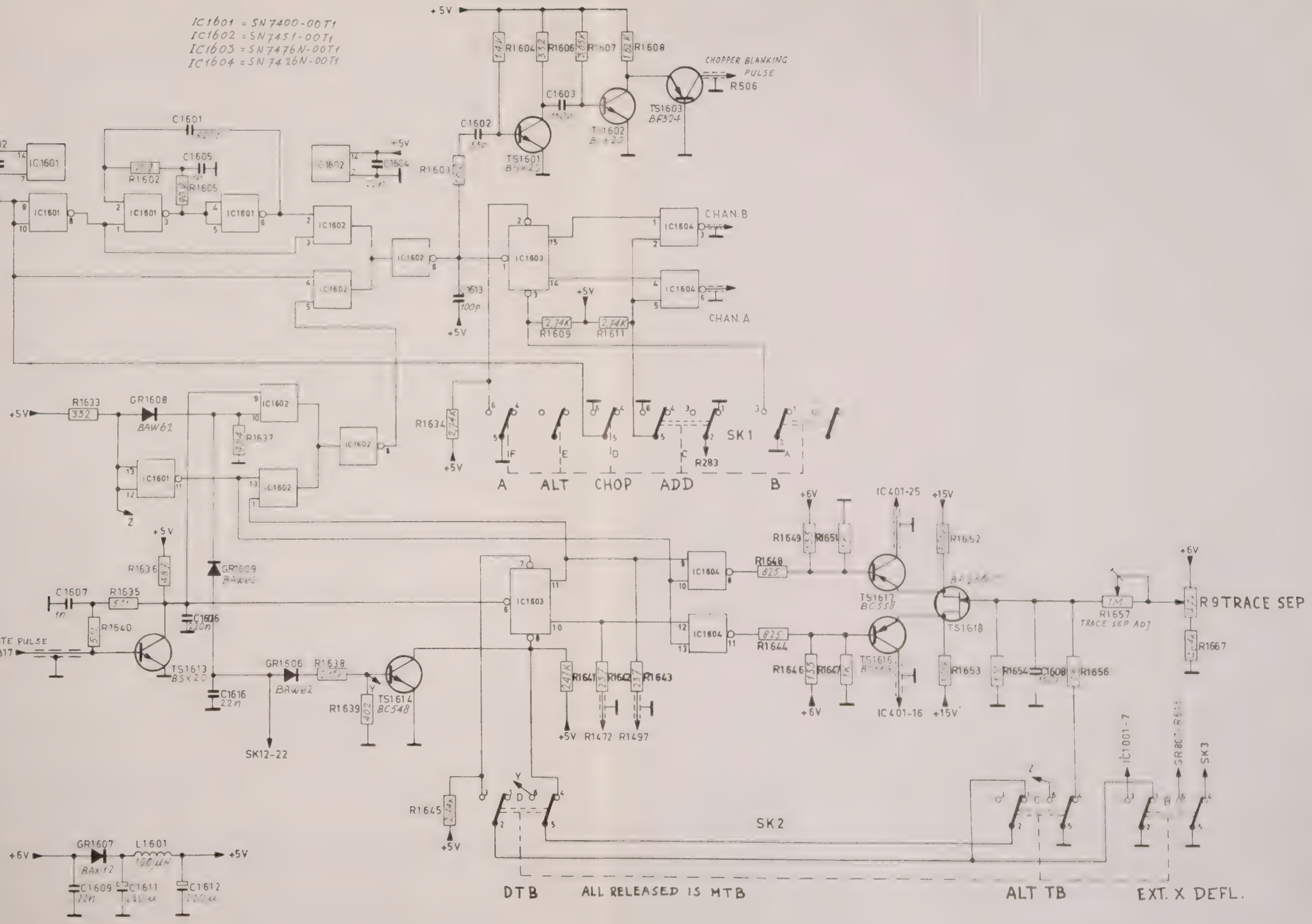


Fig. 3.57. Vertical and horizontal selection logic PM 3265E

3.9. SUPPLEMENT TO THE INSTRUCTION MANUAL FOR SPECIAL MODEL OSCILLOSCOPE PM 3265E WITH TTL TRIGGERING

The oscilloscope PM 3265E with a TTL (transistor-transistor logic) compatible trigger circuit is based on the model PM 3265E. The differences between the both models are given in this Supplement, in the order in which they affect the Instruction Manual.

1.2. CHARACTERISTICS

The following sections replace the corresponding sections in the Instruction Manual:

1.2.6.6.	Defl. coef.	200 mV	One calibrated position; Uncalibrated vernier 3:1
1.2.7.4.	Sensitivity	Int. 1 DIV Ext. 150 mV	Typical sens. 0,6 DIV
1.2.7.5.	Filter bandwidth	DC: 0 - 150 MHz AC: 30 kHz - 150 MHz	Flat response, both internal and external –3 db, both internal and external
1.2.7.6.	Level range	24 DIV –2,4 V to +2,4 V	At internal triggering At external triggering

The following sections extend section 1.2.7. TRIGGERING OF THE MAIN TIME BASE in the Instruction Manual:

This specification is valid after the instrument has warmed up for one hour and the step-attenuator balance has been adjusted in accordance with section 3.4.5.1.2. ATTENUATOR BALANCE in the Instruction Manual.

1.2.7.8.	Slope in TTL mode	+	The trigger circuit recognizes a positive going trigger only when the transitions go from a logic low to a logic high
		–	The trigger circuit recognizes a negative-going trigger only when the transitions go from a logic high to a logic low
1.2.7.9.	TTL Logic levels		
	Logic low	0,8 $V_{d.c.}$ ± 0,4 $V_{d.c.}$	Temp. range 15 - 30 deg. C
	Logic high	2,0 $V_{d.c.}$ ± 0,4 $V_{d.c.}$	Temp. range 15 - 30 deg. C
	Trigger gap	1,2 $V_{d.c.}$ ± 0,4 $V_{d.c.}$	Temp. range 15 - 30 deg. C
1.2.7.10.	Bandwidth	DC to >130 % of Y axis bandwidth (the Y input coupling is automatically switched to DC when the TTL button is depressed)	Test signal: sine -wave: external 0,5 Vp-p with offset of +0,14 $V_{d.c.}$: internal 2,5 DIV with an offset of +0,7 DIV
1.2.7.11.	Restrictions	The TTL mode may not be used together with the MAINS (a.c. line) trigger source. When the TTL mode is used in conjunction with the internal trigger sources, the signal amplitudes on channels A and B must be chosen such as to obtain approximately 2,5 DIV display of TTL logic. When the TTL mode is used in conjunction with external trigger sources, the signal must be supplied to the external-trigger input socket via a 10:1 attenuator probe.	

2.2. OPERATING INSTRUCTIONS

The following sections replace the corresponding sections in the Instruction Manual:

2.2.1.1.	AC/0/DC	
	AC depressed	Coupling via a blocking capacitor. When the TTL push-button is depressed, the AC function is overruled and the signal coupling is automatically switched to DC.
2.2.1.3.	TTL/DC/AC	
	TTL depressed	Triggering on positive logic TTL signal. Do not depress the MAINS push-button when the TTL switch is depressed. In case of external triggering in the TTL mode, the trigger

	signal must be applied to the EXT socket via a 10:1 attenuator probe. For internal triggering in the TTL mode, the trace height of the input TTL logic signal must be approximately 2,5 DIV.
DC depressed	Triggering signals are direct-coupled.
AC depressed	Coupling via a high-pass filter for frequencies over 30 kHz.

CHECKING AND ADJUSTING PROCEDURE FOR TTL MODELS

The instrument must be checked and adjusted in accordance with section 3.4. in the PM 3265 Manual and the following supplementrary procedure for TTL models.

3.4.8.1. BALANCE OF THE HORIZONTAL AMPLIFIER

(This section replaces the same section in the Instruction Manual)

- Depress push-button A of the display-mode controls.
- Depress push-buttons NORM of the NORM-INVERT controls
- Set the AMPL switches of both Y channels to .2 V/DIV and the continuous controls to CAL
- Depress push-buttons DC of the signal-coupling controls of both channels
- Set the DEL'D TIME/DIV switch to OFF
- Depress push-button AUT of the trigger-mode controls
- Depress push-button DC of the MAIN TB trigger-coupling controls
- Depress push-button A of the MAIN TB trigger-source controls
- Set the X AMPL potentiometer to CAL
- Depress push-button EXT X DEFL of the horizontal-deflection controls
- Centre the spot, using the POSITION potentiometers
- Depress push-button EXT of the MAIN TB trigger-source controls
- Check that the spot remains within 0,5 DIV from the centre of the screen; if necessary, select a different value for resistor R9033 on the MAIN TB board (Fig. 3.65)
- Check that the spot does not move when the X AMPL potentiometer is rotated clockwise and and anti-clockwise; if necessary, readjust potentiometer POS R1401 on the horizontal deflection selector board (Fig. 3.44).

3.4.8.4. X DEFLECTION WITH EXTERNAL INPUT

(This section replaces the same section in the Instruction Manual)

- Controls in the same position as in the previous check
- Apply a square-wave signal of 1,2 V, frequency 2 kHz, to the EXT input socket
- Set the X AMPL potentiometer to CAL
- Check that the trace width is 6 DIV ± 1 SUBDIV; if necessary, readjust GAIN potentiometer R1419 on the horizontal deflection selector board (Fig. 3.44)
- Readjust trimmer capacitor C2503 on the EXT INPUT circuit board (Fig. 3.63) for minimum rounding and overshoot.

3.4.8.2. X DEFLECTION VIA CHANNEL A

(This section replaces the same section in the Instruction Manual)

- Depress push-button A of the MAIN TB trigger-source controls
- Depress push-button B of the display-mode controls
- Other controls in the same position as in the previous section
- Apply a square-wave voltage of 1,2 V, frequency 2 kHz, to the channel A input socket
- Check that the trace width is 6 DIV ± 1 SUBDIV; if necessary, select a different value for resistor R9034 on the MAIN TB board (Fig. 3.65).

3.4.6.2.3. TRIGGER SLOPE IN THE TTL MODE

(This section is an extension of section 3.4.6.2. in the Instruction Manual)

- Depress push-button TTL
- Other controls in the same position as in the previous section
- Apply a sine-wave at a frequency of 2 kHz to the channel A input socket
- Find the smallest input signal at which the display remains triggered.
- Check that the starting point of the sine-wave does not move when the TRIGGER SLOPE switch is switched between + and –; if necessary, find an average setting with the aid of potentiometer R737 on the MAIN TB board (Fig. 3.36)

At this point, check and, if necessary, readjust the step-attenuator balance in accordance with section 3.4.5.1.2. ATTENUATOR BALANCE in the Instruction Manual.

3.4.6.2.4. TRIGGER SENSITIVITY IN THE TTL MODE

(This section is an extension of the same section in the Instruction Manual)

For this adjustment, a square-wave generator with variable d.c. offset is necessary.

- Depress push-button B of the display-mode controls
- Depress push-button B of the MAIN TB trigger-source controls
- Set the channel B AMPL switch to 20 mV/DIV and the vernier control to CAL
- Other controls in the same position as in the previous section
- Apply a square-wave voltage for an amplitude of 6 DIV riding on an offset for 4 DIV (Fig. 3.58) to the A, B and EXT input sockets, using T pieces and a termination pad; frequency 2 kHz

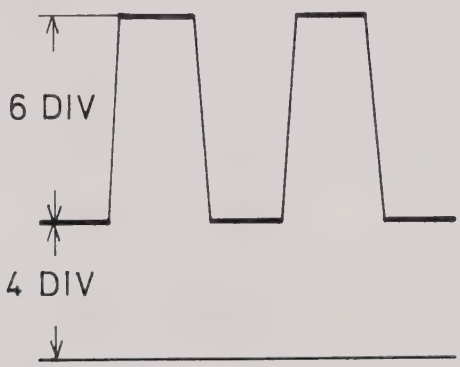


Fig. 3.58. Test signal for the trigger sensitivity in the TTL mode

- Set both AMPL switches to 200 mV
- Depress push-button EXT of the MAIN TB trigger-source controls
- Check that a triggered display is obtained; if necessary, readjust potentiometer R625 on the MAIN TB board (Fig. 3.36)
- Depress push-button B of the MAIN TB trigger-source controls
- Check that a triggered display is obtained; if necessary, readjust potentiometer R656 on the MAIN TB board (Fig. 3.36)
- Depress push-buttons A of the display-mode and trigger-source controls
- Check that a triggered display is obtained; if necessary, readjust R636 on the MAIN TB board (Fig. 3.36).

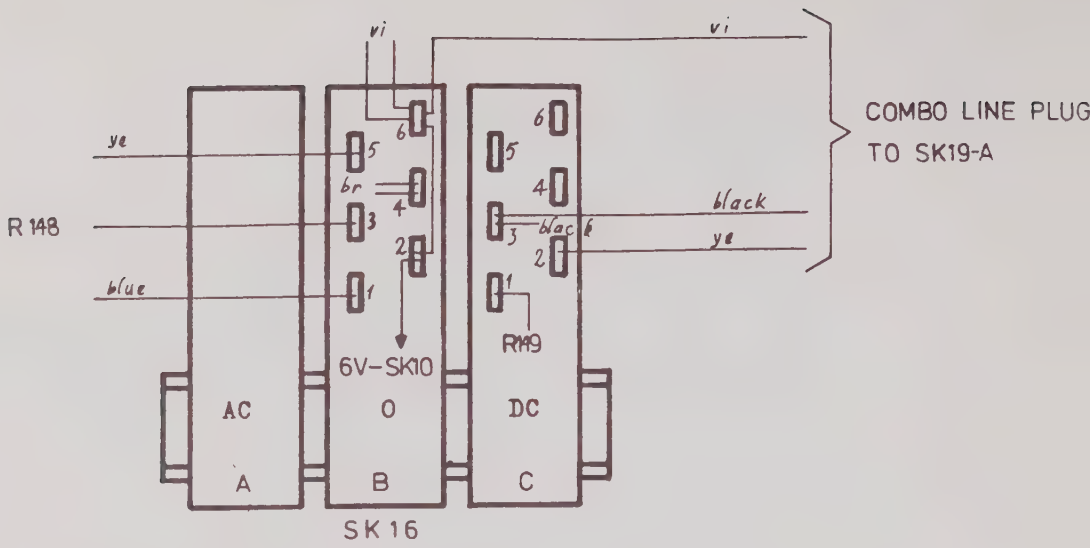


Fig. 3.59. Wiring of the AC-0-DC switch for the TTL model

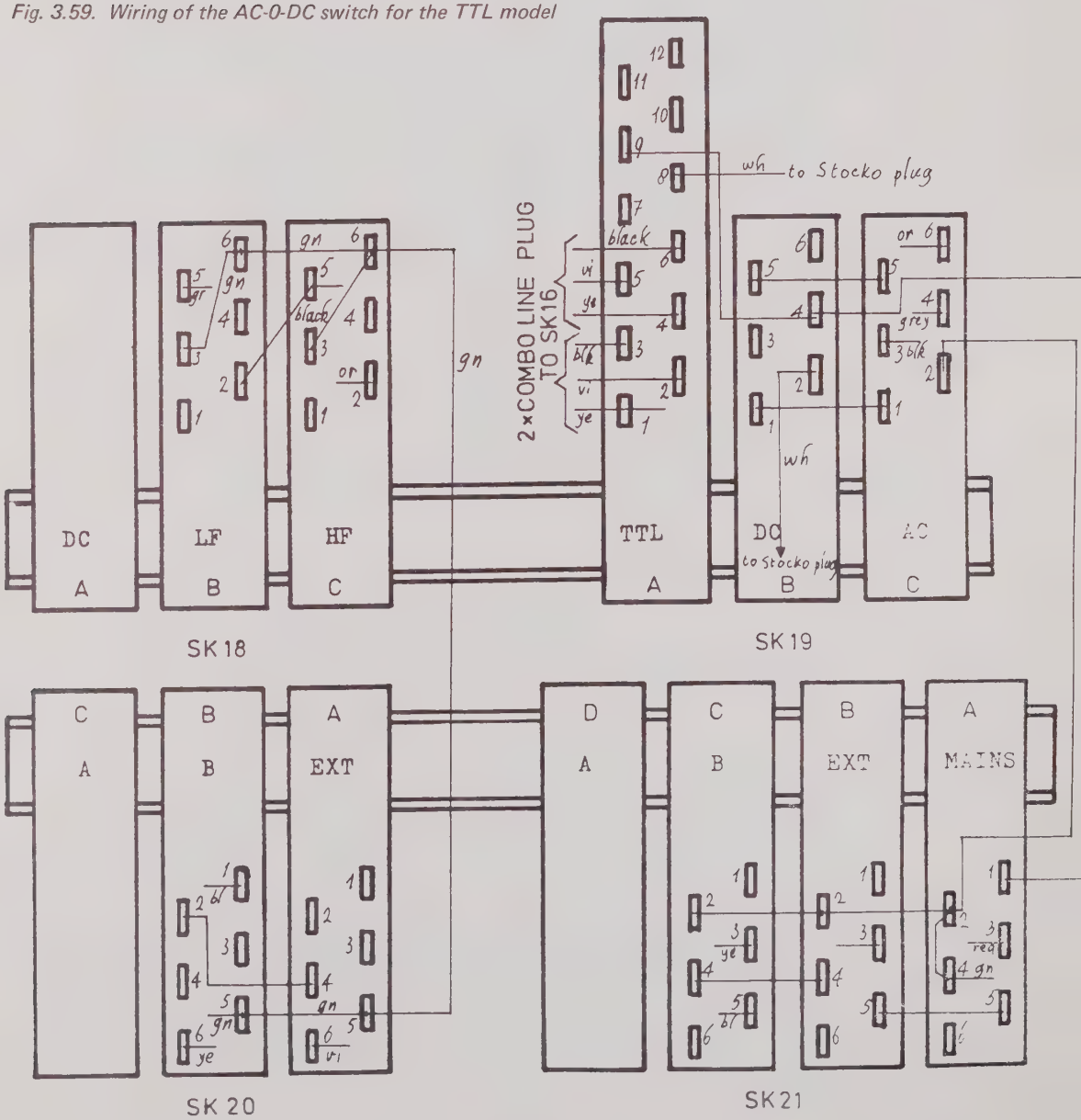


Fig. 3.60. Wiring of the TTL/DC/AC and A/B/EXT/MAINS switch for the TTL model

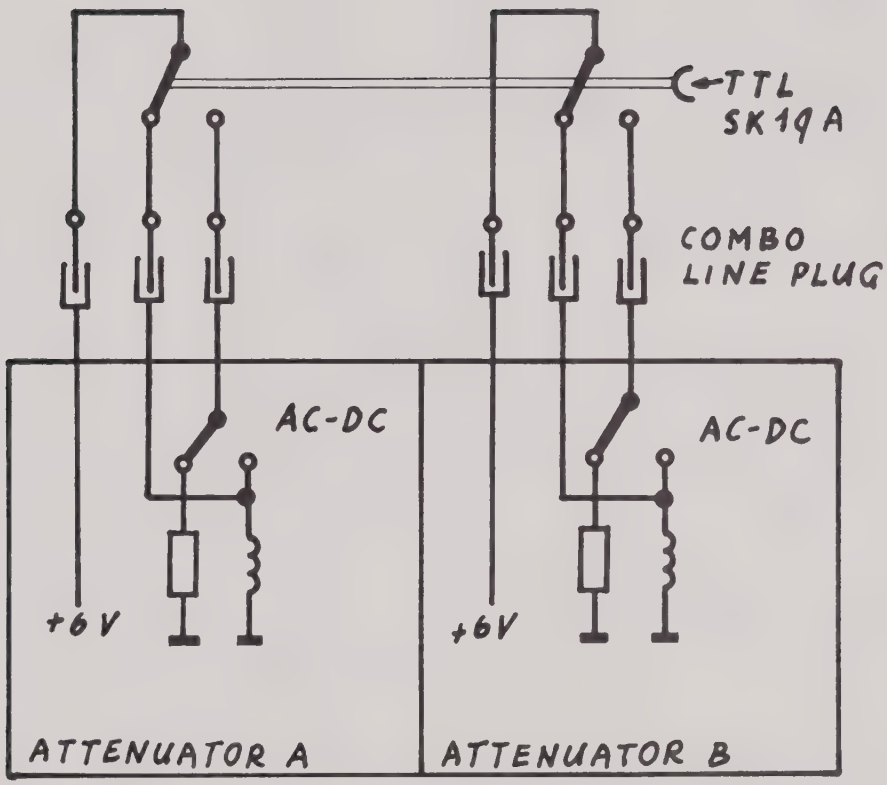


Fig. 3.61. Diagram showing the interconnection of TTL and AC/O/DC switches to overrule the AC position in the TTL mode

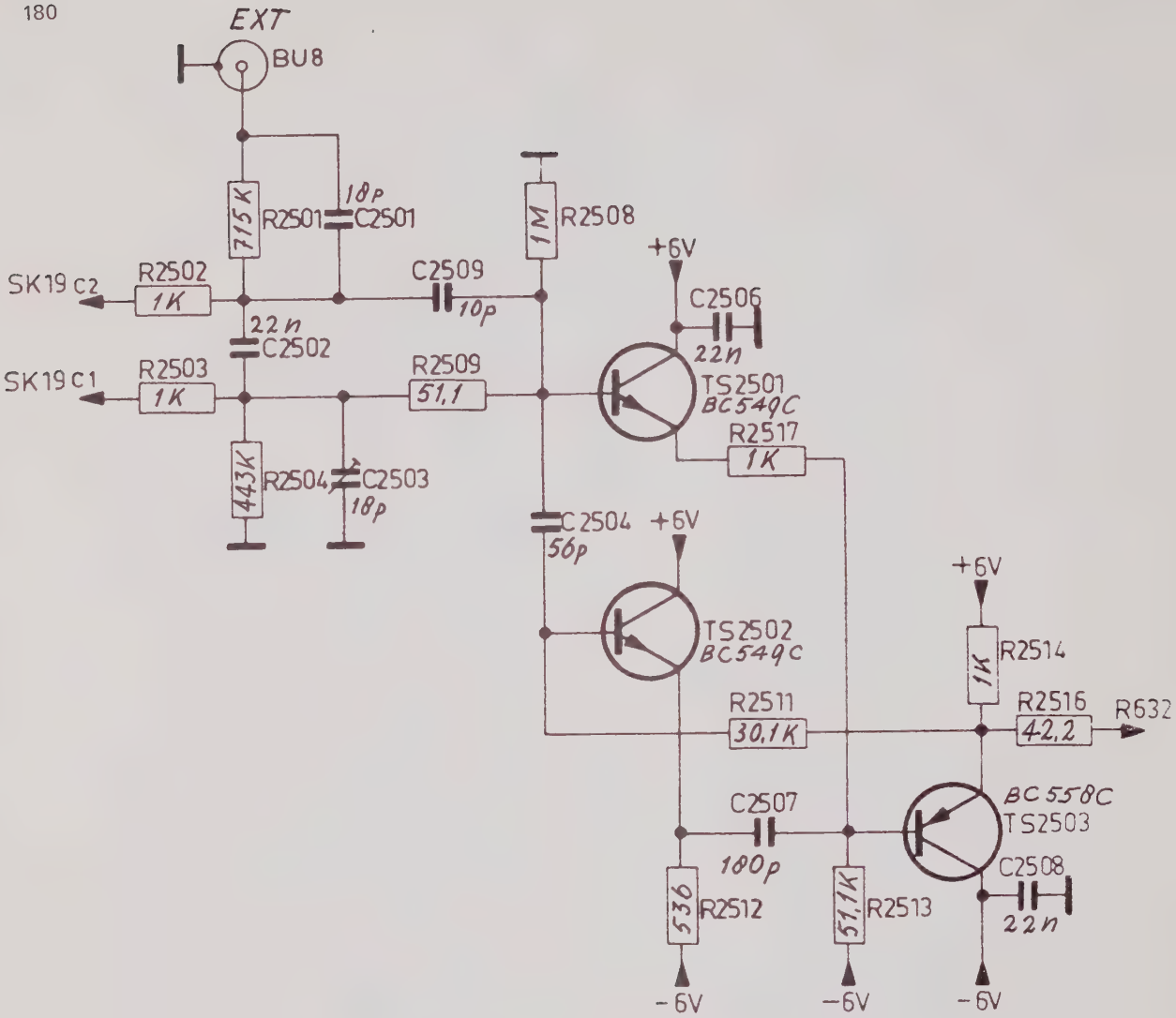


Fig. 3.62. Diagram of the EXT input circuit in the TTL model

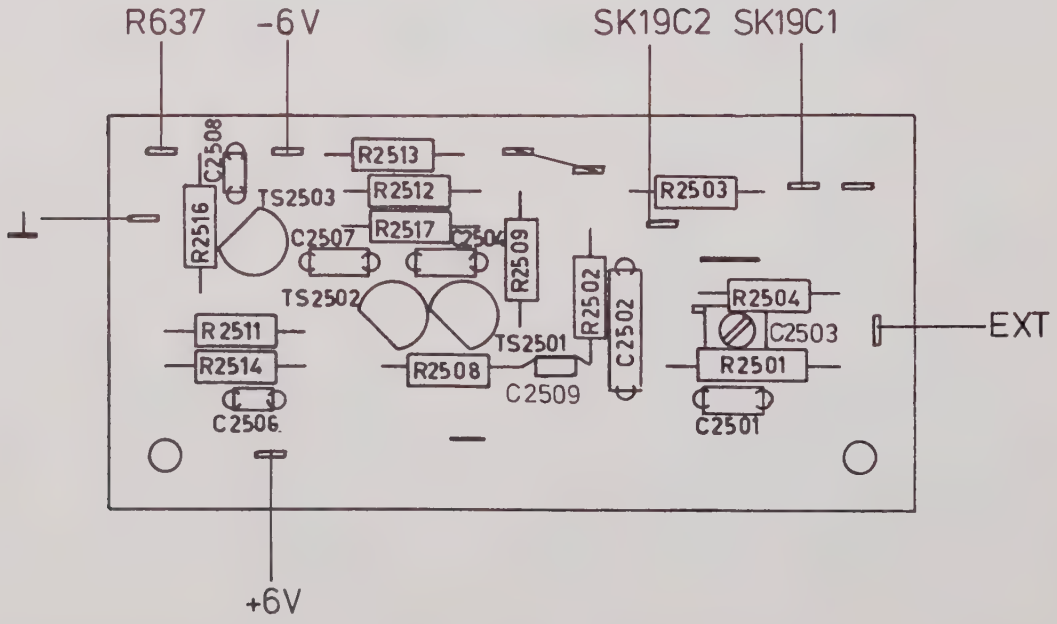
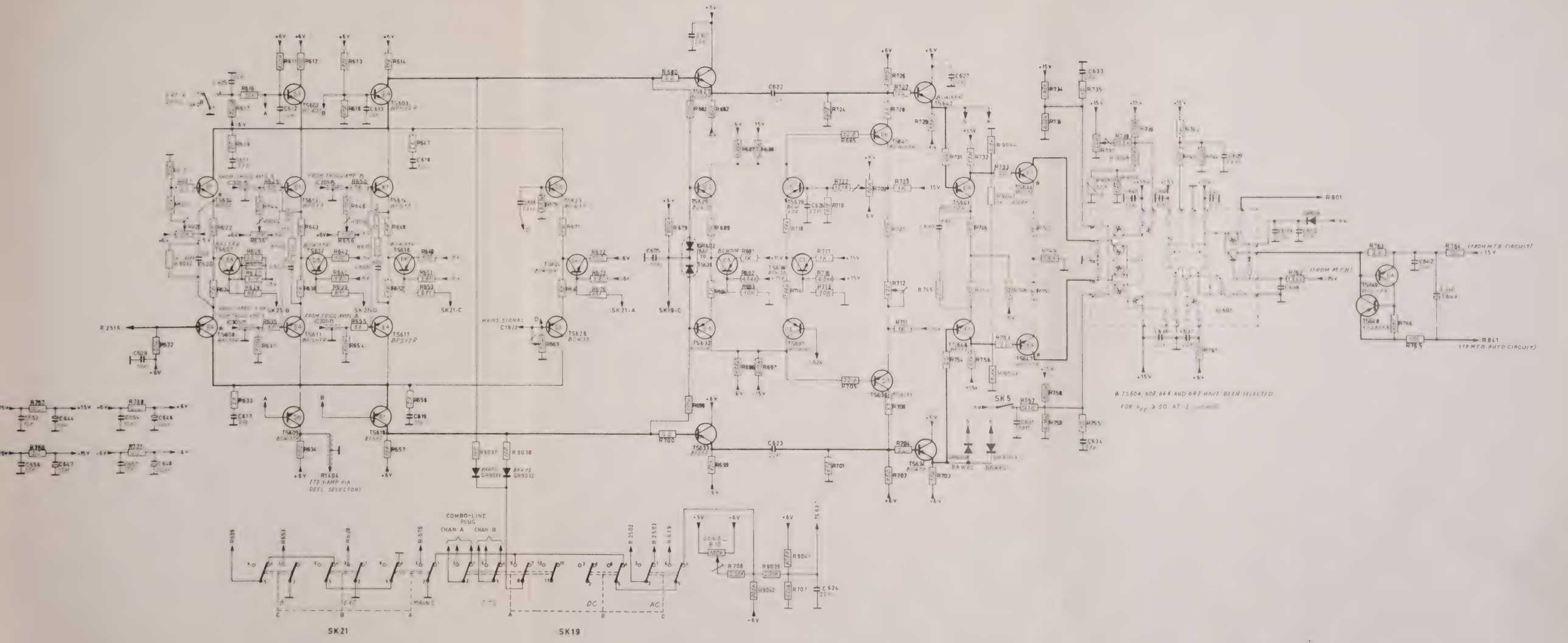


Fig. 3.63. Printed-wiring board of the EXT input circuit


SK21
SK19
SK5
COMBO-LINE PLUG
CHAN A
CHAN B
DC
AC
MAINS
(TO T-AMP VIA DEFL SELECTOR)
(FROM MTB CIRCUIT)
(TO MTB AUTO CIRCUIT)
★ TS604, 608, 644 AND 647 HAVE BEEN SELECTED FOR h_{FE} ≥ 50 AT 1

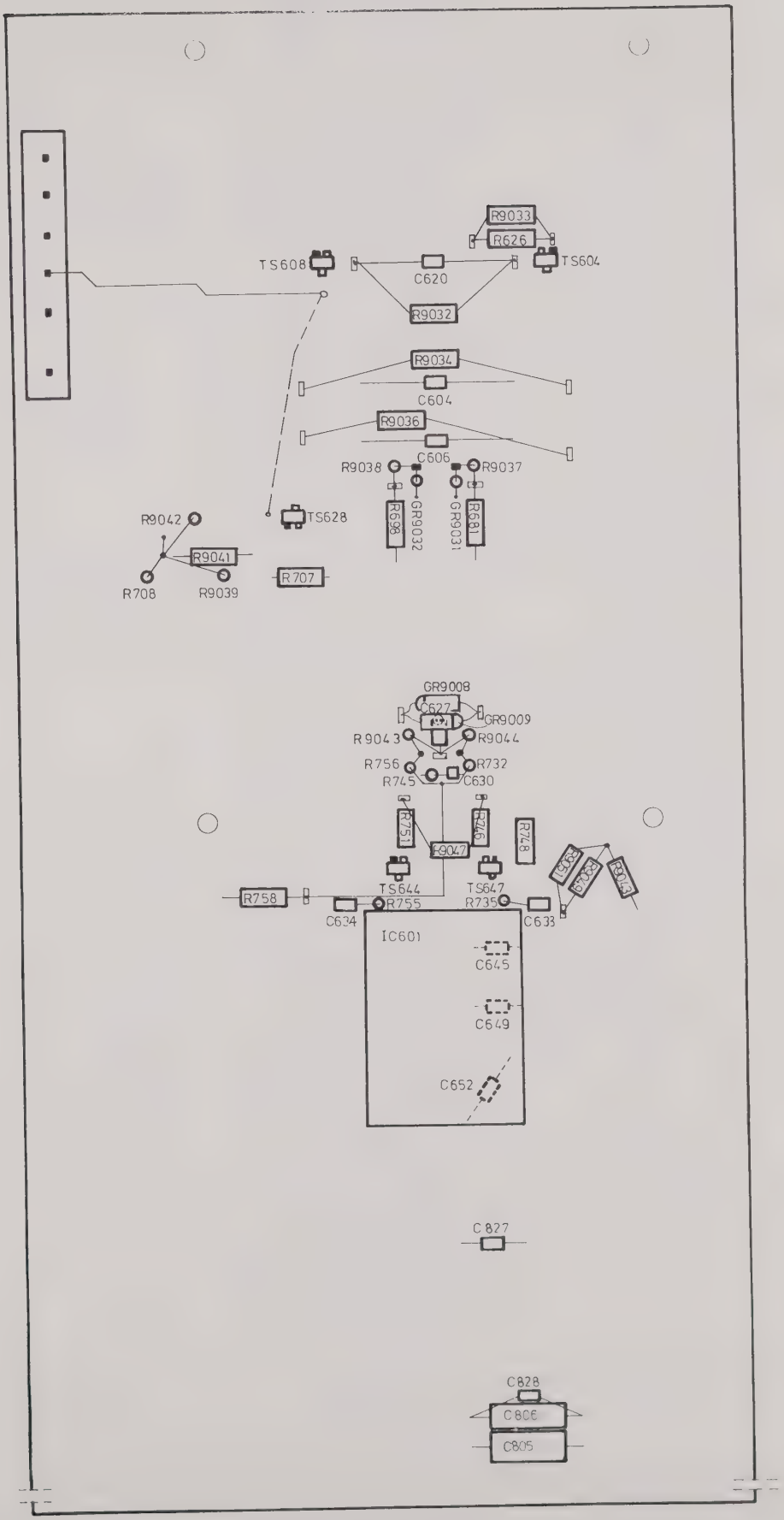


Fig. 3.65. Printed wiring board of the MAIN TB trigger circuit showing the different parts in the TTL model

CODING SYSTEM OF FAILURE REPORTING FOR QUALITY ASSESSMENT OF T & M INSTRUMENTS

(excl. potentiometric recorders)

The information contents of the coded failure description is necessary for our computerized processing of quality data.

Since the reporting of repair and maintenance routines must be complete and exact, we give you an example of a correctly filled-out PHILIPS SERVICE Job sheet.

① Country	② Day Month Year	③ Typenumber /Version	④ Factory/Serial no.
32	150475	OPM 3260 02	DO 0078 3

CODED FAILURE DESCRIPTION ⑥

⑤ Nature of call	Location	Component/sequence no.	Category
☐ Installation ☐ Pre sale repair ☐ Preventive maintenance ☒ Corrective maintenance ☐ Other	0021	TS 0607 R 0063 1 99 0001	5 2 4

⑦ *Job completed* ☒

Working time ⑧ 12 Hrs

Detailed description of the information to be entered in the various boxes:

①Country: 32 = Switzerland

②Day Month Year 150475 = 15 April 1975

③Type number/Version OPM 3260 02 = Oscilloscope PM 3260, version 02 (in later oscilloscopes this number is placed in front of the serial no)

④Factory/Serial number DO 0078 3 = DO 783 These data are mentioned on the type plate of the instrument

⑤ Nature of call: Enter a cross in the relevant box

⑥ Coded failure description

Location

☐☐☐☐

These four boxes are used to isolate the problem area. Write the code of the part in which the fault occurs, e.g. unit no or mechanical item no of this part (refer to 'PARTS LISTS' in the manual).

Example: 0001 for Unit 1
000A for Unit A
0075 for item 75

If units are not numbered, do not fill in the four boxes; see Example Job sheet.

Component/sequence no.

☐☐☐☐☐☐

These six boxes are intended to pinpoint the faulty component.

A. Enter the component designation as used in the circuit diagram. If the designation is alfa-numeric, the letters must be written (starting from the left) in the two left-hand boxes and the figures must be written (in such a way that the last digit occupies the right-most box) in the four right-hand boxes.

B. Parts not identified in the circuit diagram:

990000 Unknown/Not applicable
990001 Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.)
990002 Knob (incl. dial knob, cap, etc.)
990003 Probe (only if attached to instrument)
990004 Leads and associated plugs
990005 Holder (valve, transistor, fuse, board, etc.)
990006 Complete unit (p.w. board, h.t. unit, etc.)
990007 Accessory (only those without type number)
990008 Documentation (manual, supplement, etc.)
990009 Foreign object
990099 Miscellaneous

Category

☐

0 Unknown, not applicable (fault not present, intermittent or disappeared)
1 Software error
2 Readjustment
3 Electrical repair (wiring, solder joint, etc.)
4 Mechanical repair (polishing, filing, remachining, etc.)
5 Replacement (of transistor, resistor, etc.)
6 Cleaning and/or lubrication
7 Operator error
8 Missing items (on pre-sale test)
9 Environmental requirements are not met

⑦ Job completed: Enter a cross when the job has been completed.

⑧ Working time: Enter the total number of working hours spent in connection with the job (excluding travelling, waiting time, etc.), using the last box for tenths of hours.

☐☐12 = 1,2 working hours (1 h 12 min.)

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